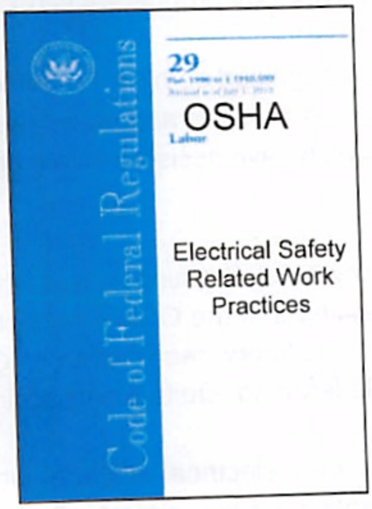
NFPA 70E, OSHA and You: Insight for Implementation

Interactive Workbook

INCLUDING

OSHA-NFPA 70E Cross-Reference


Code of Federal Regulations
29
OSHA
Labor
Electrical Safety Related Work Practices

NFPA
70E
Standard for Electrical Safety in the Workplace
Standard | 2024

®NFPA

John "Grizzy" Grzywacz, Professor Emeritus
OSHA National Training Institute
oshaprofessor.com
oshaprofessor@yahoo.com
847-436-7745

"Grizzy", as he likes to be called has been recognized by OSHA's National Office in Washington D.C. as both a National Electrical Code (NEC®) historian as well as "the best electrical safety trainer in the country!" Certainly at the very least Grizzy has been OSHA's electrical safety "go-to guy" and has been instrumental in shaping and interpreting OSHA policy and regulations for several decades.

Having spent most of his OSHA career on faculty at the OSHA National Training Institute, Grizzy has trained OSHA compliance officers, appeared as OSHA's electrical expert, and guided hundreds of electrical fatality investigations. Grizzy continues to train OSHA compliance officers and personnel coast to coast, as well as still providing investigative assistance to the Agency on fatality investigations and significant cases. His electrical expertise has not only shaped OSHA policy but also the OSHA Electrical Standard's. Grizzy is currently a member of the ASTM F-18 Committee which writes the "Electrical Protective Equipment for Workers" standards.

Licensed by the Department of Education, and prior to his OSHA career, Grizzy had been both an educator and administrator for various public and private schools and held the position of Electronic Department Chairman and Director of Education at a New York City proprietary school.

In addition to being a professional speaker and nationally recognized seminar leader with over 40,000 hours of platform experience, Grizzy has lectured at numerous colleges and universities all across the US and has numerous published works in video and print which have assisted safety professionals and helped workers for decades

Recognized nationally as preeminent in electrical regulatory safety training, private corporations and agencies outside of OSHA are now obtaining the same training that the OSHA inspectors obtain form Grizzy, as well as insight into navigating the complex regulatory requirements. Grizzys training philosophy is that students/attendees should have fun while learning. Quite a concept!

Grizzys passion for electricity and decades of collecting rare electrical artifacts which he is now exhibiting and demonstrating affords attendees of his events a unique opportunity to actually see a "slice of history". In fact his events have been characterized by attendees: "It's like watching the History Channel, only live!"

Grizzy is frequently commissioned to present many of his unique and spectacular high voltage shows at major professional conferences and other conventions including Sci-Fi cons, and Steampunk festivals throughout the U.S.

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Table of Contents

Page 2	Hazards of Electricity
Page 11	Electrocution Levels
Page 14	Electrical Injuries 1912
Page 15	Electrocution Threshold Chart
Page 16	Standards Overview and Categories
Page 22	NFPA 70E Chapter 1 "Safety Related Work Practices"
Page 29	Unqualified Person and Portable Electric Equipment
Page 36	Qualified Worker
Page 39	~~Shock~~ Electrocution Hazard Analysis and Approach Boundaries
Page 44	LOTO
Page 49	Exceptions to LOTO
Page 55	Insulated Electrical PPE
Page 65	Insulated and Insulating Hand Tools
Page 66	Arc Flash/Arc Blast, Hazard Analysis and Protective Clothing
Page 75	Electrical Meter Category Ratings
Page 76	OSHA's ESRWP Standard Outline
Page 77	OSHA's ESRWP Standard to 70E Cross Reference

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OSHA
Electrical Safety Related Work Practices
NFPA
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NFPA 70E, OSHA and You:
Insight for Implementation

John "Grizzy" Grzywacz, Professor Emeritus
OSHA National Training Institute

- OSHA National Training Institute
- OSHA's Nationwide Electrical Expert
- Lead Fatality Investigations & Conduct Forensic investigations
- Train Investigators & Safety Professionals
- Published Author
- Preeminent in Electrical Regulatory Safety
- Keynote Presentations & Shows at Professional Conferences and other Conventions

NFPA **TRAINING NEWS**
We develop the code. We know the code. We teach the code.

NFPA – You don't enforce the code!

What is an AHJ?

Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

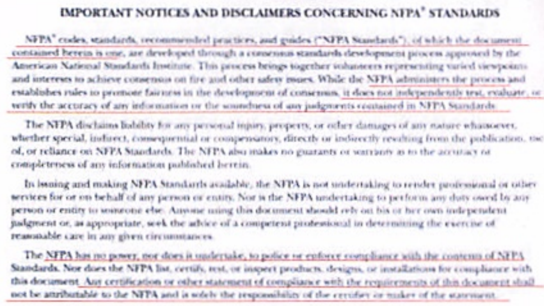
While NFPA 70E might be helpful in achieving compliance with the OSHA regulatory requirements/standards, other elements of 70E are in direct violation of OSHA and should not be followed.

News Flash

NFPA confirms what Grizzy has been saying for years and publishes it in NFPA document!

"Some requirements contained in NFPA 70E are in direct violation of OSHA requirements and can even result in "willful" OSHA citations." - Grizzy

"Following NFPA 70E to the letter would be in direct violation of OSHA Standards and can result in serious or even willful citations from OSHA." - Grizzy



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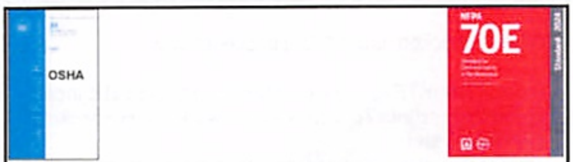


Wait! If I follow NFPA 70E, doesn't that insure compliance with OSHA?

What's OSHA require for electrical safety?

What do I need to know to be in compliance with OSHA?

What are OSHA inspectors (CSHO's) likely to ask me?

What is a "qualified" person under these standards?

What is an "unqualified" person under these standards?

Hazards of Electricity

NFPA 70E Article 110.4(A) Electrical Safety Training *"employees shall be trained to understand the specific hazards associated with electrical energy."*

OSHA 1910.332 Employees shall be trained in and familiar with the safety-related work practices required by 1910.331 through 1910.335 that pertain to their respective job assignments.

Electrical Hazards

What's the first thing that comes to mind ?

______ → Direct ______

______ → Reaction ______

______

______

______

______ / ______

What electrical hazard is responsible for nearly 80% of the accidents, incidents and fatalities among *Unqualified* Workers?

Electrocution

Usually associated with a lack of equipment grounding, lack of GFCI use & lack of training!

An involuntary muscle reaction from shock can cause a fall which could still be fatal!

How about using a power tool like a saws all, involuntary reaction could cause the blade to contact parts of the body which are undesirable to say the least.

Worker shocked, falls 25 feet at school gym

HOUSTON (KTRK) -- It was a terrible accident at a local elementary school Tuesday when a worker was shocked, then fell 25 feet.

It happened at Nitsch Elementary School on West Mount Houston. The 31-year-old electrical contract worker was working on lights in the gym when he apparently touched a live circuit and fell.

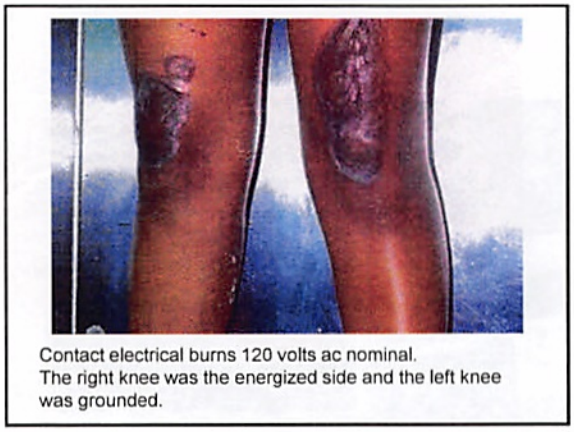
He was rushed to the hospital, where he was pronounced dead.

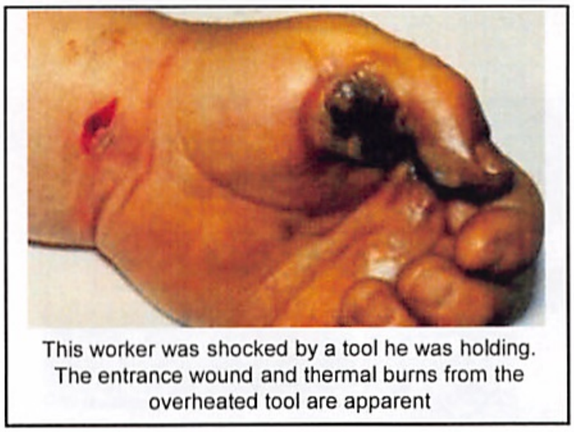
- Burns
  - Burns can result when a person contacts energized parts resulting in high current through body parts.
  - Electrical burns of this type usually require specialized burn treatment and result in loss of body parts.

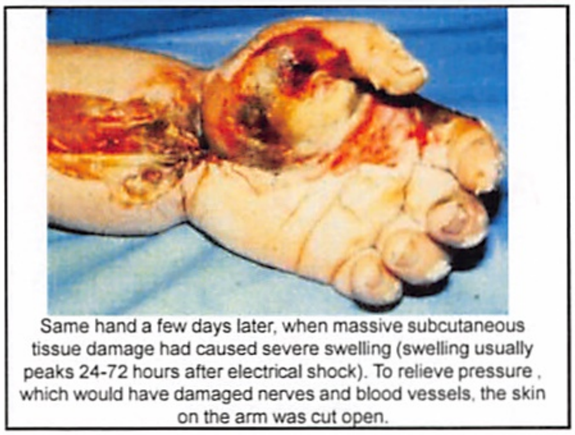
Excessive electricity flowing through the human body can cause serious damage to internal organs.

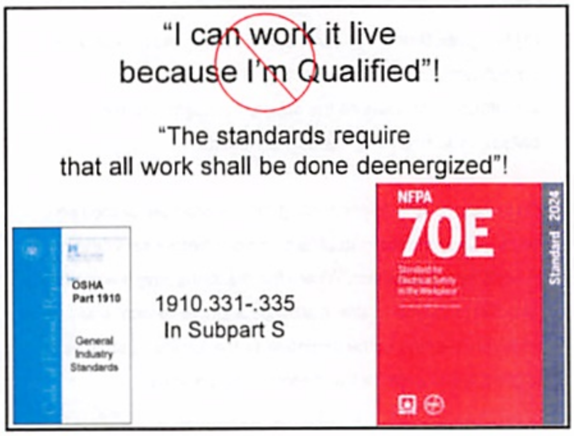
Resulting medical problems include hemorrhage (or internal bleeding), tissue destruction, and nerve or muscle damage.

These internal injuries may not be immediately apparent to the victim or observers; however, left untreated, they can result in death.


Contact electrical burns 120 volts ac nominal.
The right knee was the energized side and the left knee was grounded.


This worker was shocked by a tool he was holding. The entrance wound and thermal burns from the overheated tool are apparent

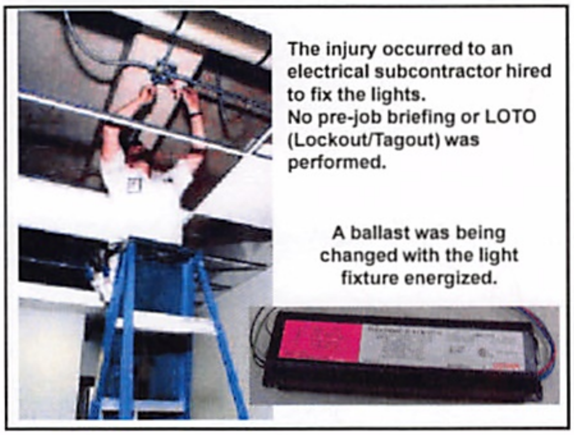

Same hand a few days later, when massive subcutaneous tissue damage had caused severe swelling (swelling usually peaks 24-72 hours after electrical shock). To relieve pressure , which would have damaged nerves and blood vessels, the skin on the arm was cut open.


"I can work it live because I'm Qualified"!

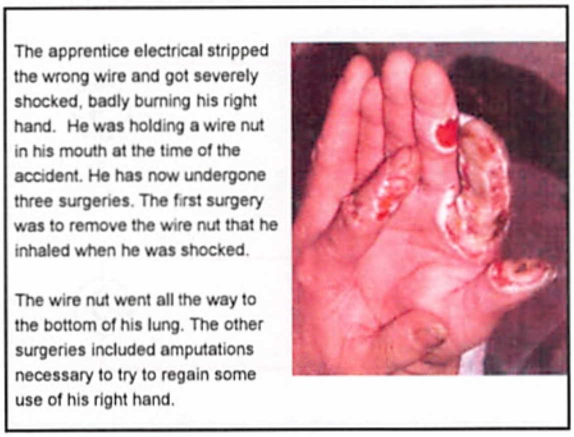
"The standards require that all work shall be done deenergized"!

1910.331-.335
In Subpart S

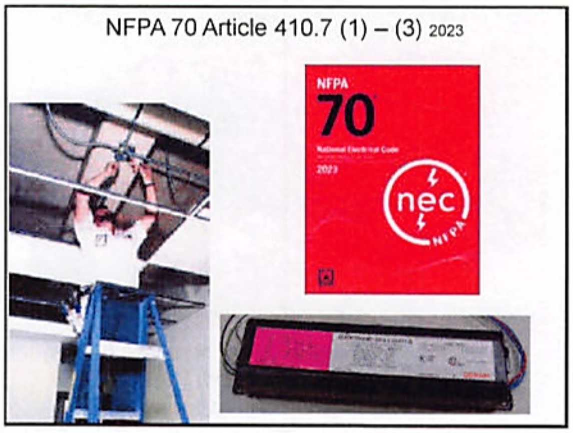
OSHA
Part 1910
General Industry Standards
NFPA
70E
Standard 2024


The injury occurred to an electrical subcontractor hired to fix the lights.
No pre-job briefing or LOTO (Lockout/Tagout) was performed.

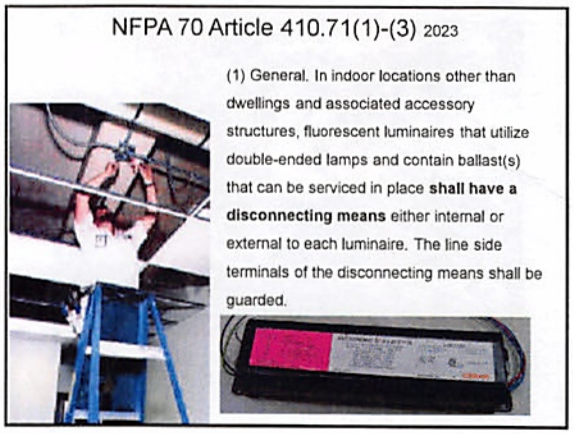
A ballast was being changed with the light fixture energized.


The apprentice electrical stripped the wrong wire and got severely shocked, badly burning his right hand. He was holding a wire nut in his mouth at the time of the accident. He has now undergone three surgeries. The first surgery was to remove the wire nut that he inhaled when he was shocked.

The wire nut went all the way to the bottom of his lung. The other surgeries included amputations necessary to try to regain some use of his right hand.



NFPA 70 Article 410.7 (1) – (3) 2023

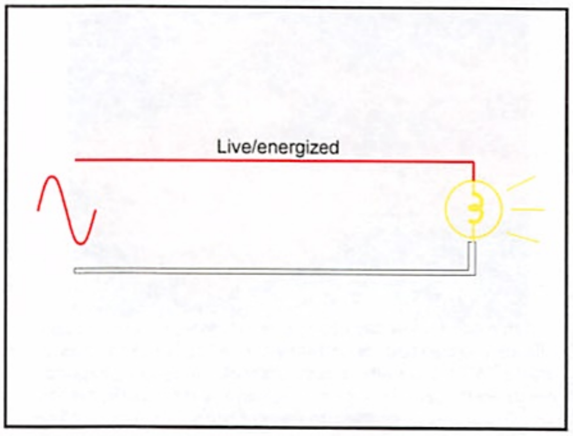


NFPA 70 Article 410.71(1)-(3) 2023

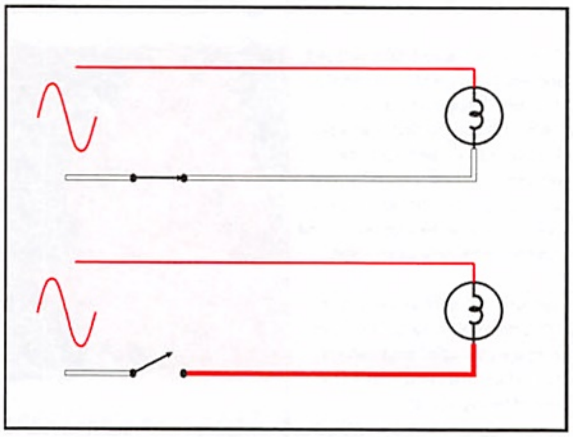
(1) General. In indoor locations other than dwellings and associated accessory structures, fluorescent luminaires that utilize double-ended lamps and contain ballast(s) that can be serviced in place **shall have a disconnecting means** either internal or external to each luminaire. The line side terminals of the disconnecting means shall be guarded.

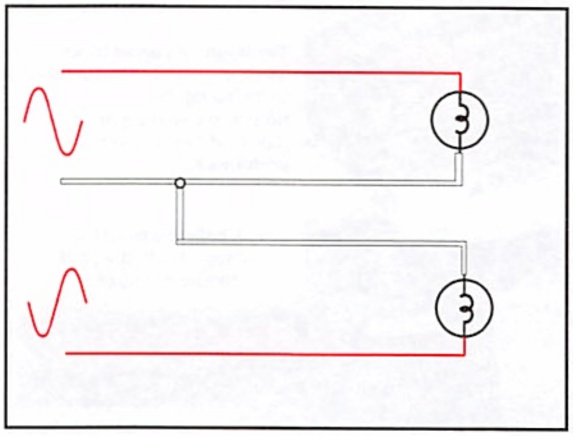
(2) Multiwire Branch Circuits. When connected to multiwire branch circuits, the disconnecting means shall simultaneously break all the supply conductors to the ballast, including the grounded conductor.

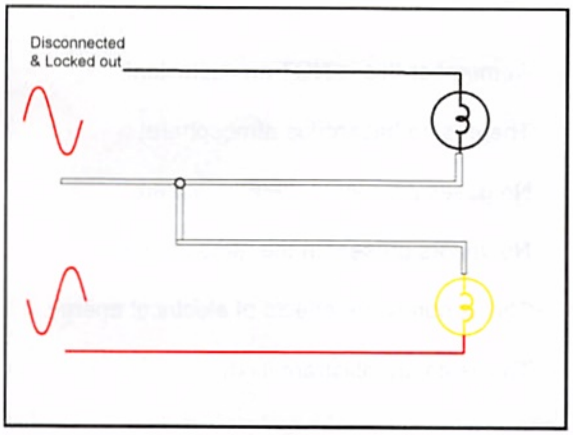
(3) Location. The disconnecting means shall be located so as to be accessible to qualified persons before servicing or maintaining the ballast. Where the disconnecting means is external to the luminaire, it shall be a single device, and shall be attached to the luminaire or the luminaire shall be located within sight of the disconnecting means.

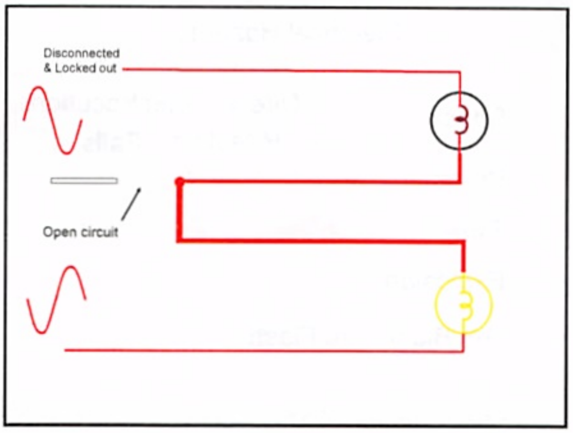


Live/energized






Disconnected
& Locked out


Disconnected
& Locked out
Open circuit

Fire - Electricity continues to be one of the primary causes of fire in both the Home and Workplace.

A vast majority of the fires are caused by high resistance (loose) connections.

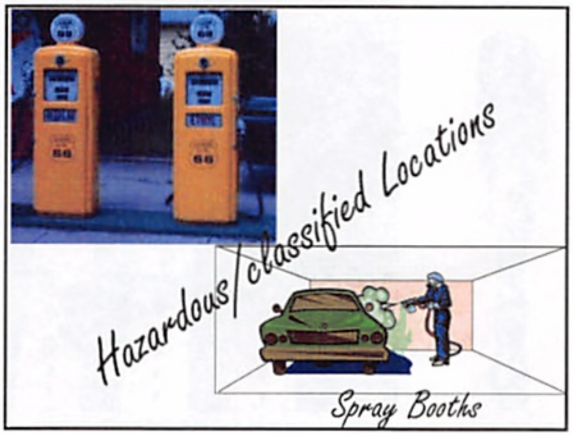
Electrical Hazards

Shock → Direct Electrocution
→ Reaction Falls

Burns

Fire

- Explosions
  - Explosions occur when electricity provides an ignition source for an explosive mixture in the surrounding atmosphere.
  - This typically happens when electrical equipment is improperly installed or maintained in a Classified Location.


Hazardous/classified Locations
Spray Booths

Electrical Hazards

Shock → Direct Electrocution
→ Reaction Falls

Burns

Fire

Explosion

Arc Blast / Arc Flash

Remember this is NOT an explosion!

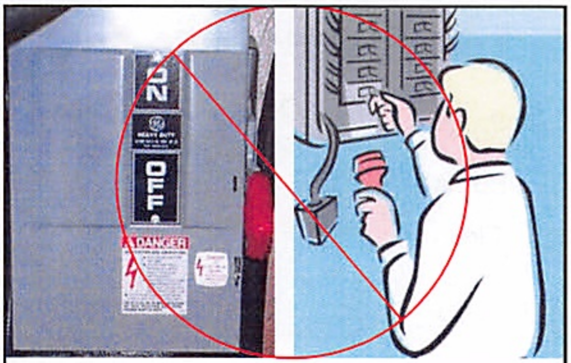
There is no hazardous atmosphere!

No gases present in the atmosphere.

No vapors present in the atmosphere.

This is purely the effects of electrical energy.

This is an arc blast/arc flash.



Use the stand clear rule/practice!

Arc Blast / Arc Flash

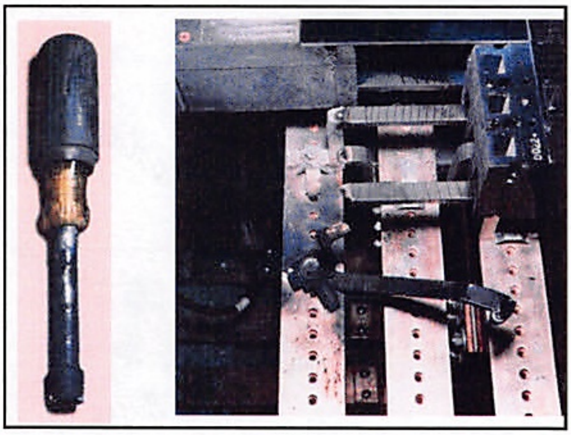
Time duration of event 30 ms to 500ms

Temperatures as high as 35,000°

Pressure Wave 15 tons / m^2

Projectiles

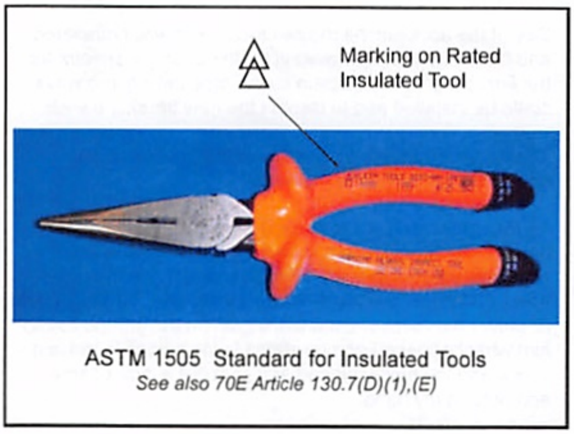
Vaporized copper expands 67,000 x volumetrically



Insulated tools are required
130.7(D)(1), 1910.335(a)(2)(i)

1910.335(a)(2)(i) When working near exposed energized conductors or circuit parts, each employee shall use insulated tools or handling equipment if the tools or handling equipment might make contact with such conductors or parts.

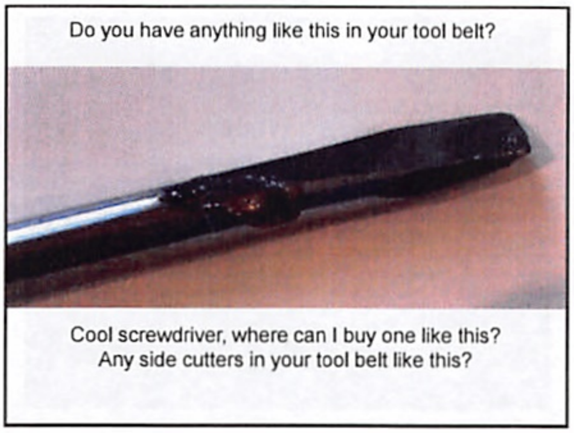
130.7(D)(1) Insulated Tools and Equipment. Tools and handling equipment Used within the restricted approach boundary shall be insulated.



Marking on Rated Insulated Tool

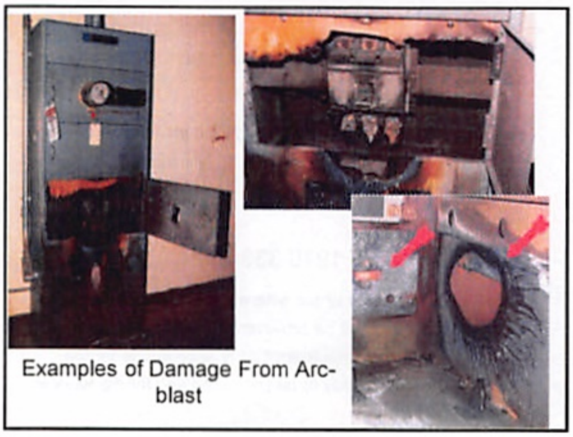
ASTM 1505 Standard for Insulated Tools

See also 70E Article 130.7(D)(1),(E)

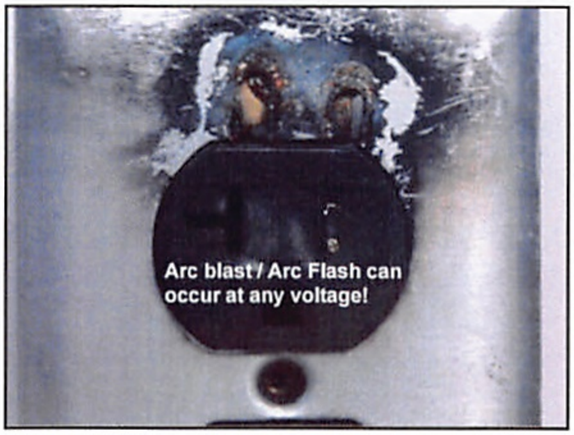


Do you have anything like this in your tool belt?

Cool screwdriver, where can I buy one like this?
Any side cutters in your tool belt like this?



Examples of Damage From Arc-blast



Arc blast / Arc Flash can occur at any voltage!

Arc Blast/Arc Flash is not voltage dependent but energy dependent regarding its magnitude

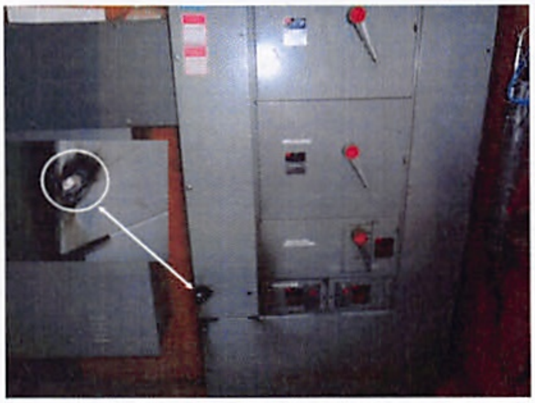
Available fault Current/Incident Energy

Overcurrent Clearing Time

Increase working distance
(remote devices)

PPE (last resort)

For non electrical workers: Distance is our friend!



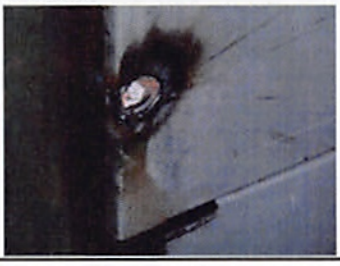
Day of the accident: All the electrical work was completed and the electrician was waiting for the county inspector for the final progress inspection so the drop ceiling and walls could be installed and to inspect the new breaker panels

The inspector arrives looks over all the new electrical equipment installed and passes it.

As the inspector turns to leave the electrician begins to replace the cover, installs the screws from the top and works his way down gets to the bottom left corner on the panel and the inspector hears an explosion. The inspector re enters the room see the electrician on the ground asked him what happened and he states I was putting in the last screw and the box exploded and shot out a 2 foot flame and burned my hand.

Electrician suffers 3rd degree burns to the left hand.

It was determined that while he was reinstalling a screw, not the original screw but a 1 inch pan head screw, and the electrician contacted the main 600 amp feeder cable.



Article 130.7(C)(7)(b) – Hand and Arm Arc Flash Protection

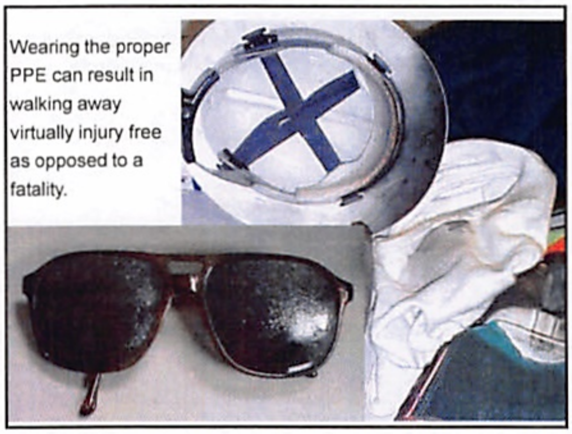
- Hand and arm protection shall be worn where there is a possible exposure to arc flash burn.

OSHA 1910.333(a)(1)(i)

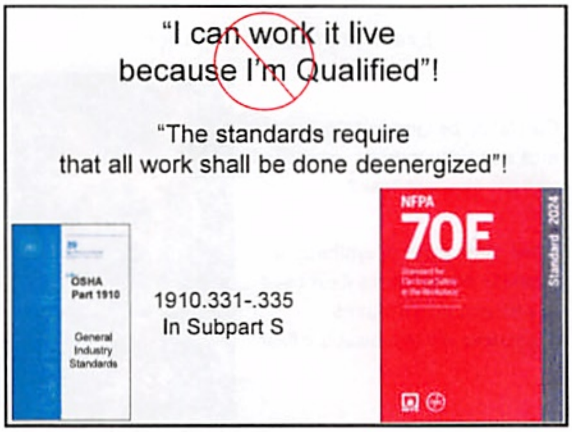
- Employees working in areas where there are potential electrical hazards shall be provided with, and shall use, electrical protective equipment that is appropriate for the specific parts of the body to be protected and for the work to be performed.

Very experienced journeyman, supervisor and business owner. Breaker got "bumped" by a fork lift, lights went out and my friend was called. Reached up to pull the breaker handle down to the OFF position, said it felt like it was broken, but tried it anyway.....BOOM

What was the hazard that resulted in this burn injury?



Wearing the proper PPE can result in walking away virtually injury free as opposed to a fatality.



“I can work it live because I’m Qualified”!

“The standards require that all work shall be done deenergized”!

1910.331-.335
In Subpart S

OSHA
Part 1910
General
Industry
Standards
NFPA
70E
Standard 2024

Electrical Hazards

Shock → Direct Electrocution
→ Reaction Falls

Burns

Fire

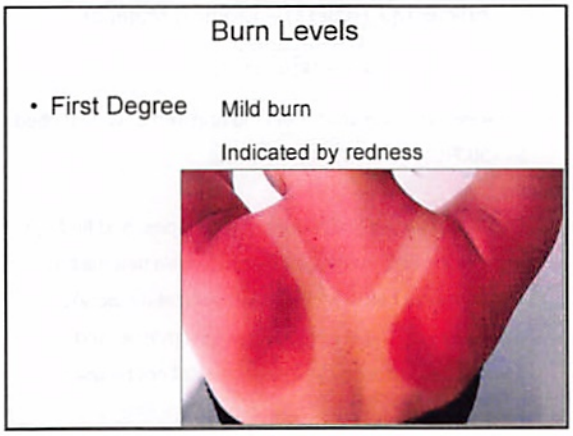
Explosions

Arc Blast / Arc Flash

80 % of the electrically related accidents incidents and fatalities among *Qualified Workers*

Caused by

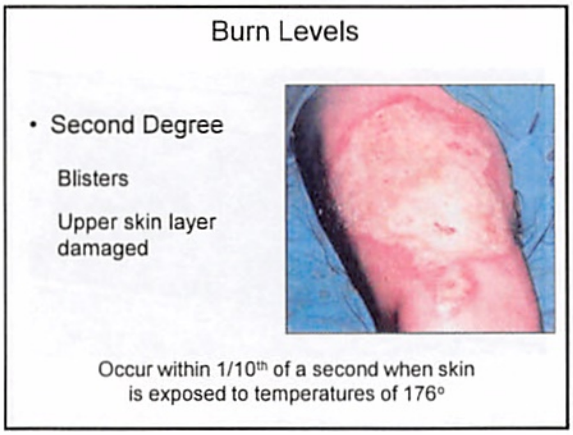
Arc Blast / Arc Flash



Burn Levels

- First Degree Mild burn

Indicated by redness



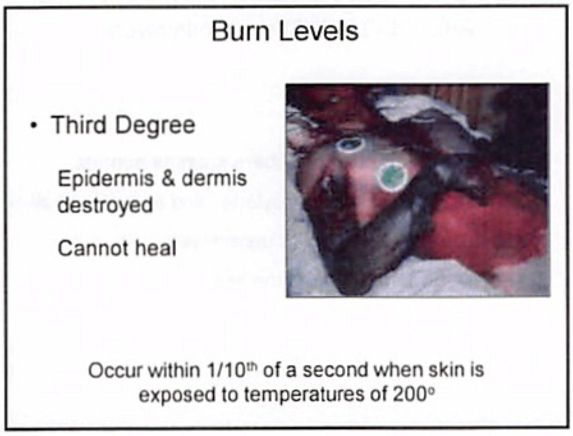
Burn Levels

- Second Degree

Blisters

Upper skin layer damaged

Occur within 1/10th of a second when skin is exposed to temperatures of 176°



Burn Levels

- Third Degree

Epidermis & dermis destroyed

Cannot heal

Occur within 1/10th of a second when skin is exposed to temperatures of 200°

- Fourth Degree

Destroy muscle tissue, bones, and tendons

Example of Clothing Ignition

Can fabric be ignited if exposed to arcs and temperatures associated with arc blast/arc flash?

What will happen to synthetic or synthetic blend fabrics if exposed to arcs and temperatures associated with arc blast/arc flash?

Article 130.7(C)(11) – Clothing Material Characteristics

OSHA 1910.333(a)(1)

- Arc-rated clothing shall meet the requirements described in 130.7(C)(14) & (C)(12). ASTM stds.
- Clothing consisting of fabrics, zipper tapes, and findings made from flammable synthetic materials that melt at temperatures below 315°C, such as acetate, acrylic, nylon, polyester, polyethylene, polypropylene, and spandex, either alone or in blends shall not be used.

Article 130.7(C)(12) – Clothing and Other Apparel Not Permitted

- Clothing and other apparel (such as hard hat liners and hair nets) made from materials that do not meet the requirements of 130.(C)(11) regarding melting, or made from materials that do not meet the flammability requirements shall not be permitted to be worn.

Article 130.7(C)(9)(c) – Underlayers

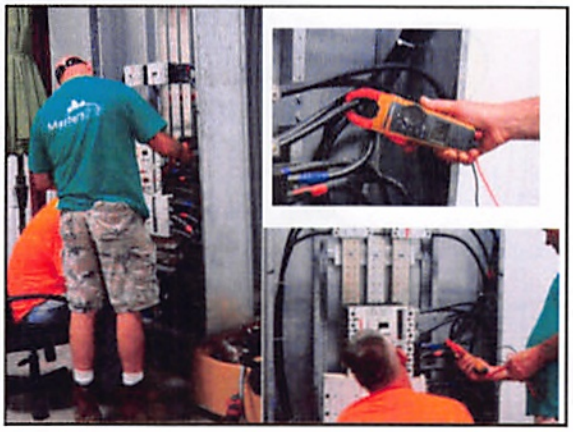
- **Underlayers.** Meltable fibers such as acetate, nylon, polyester, polypropylene, and spandex shall not be permitted in fabric underlayers (undergarments) next to the skin.

OSHA Investigations Leads to $148,500 in Penalties for Patrick Cudahy, Inc.

MILWAUKEE, Wis. -- Meat packing giant Patrick Cudahy, Inc., is facing $148,500 in fines proposed by the U.S. Labor Department's Occupational Safety and Health Administration (OSHA) following an inspection opened in May 2003 in response to reports of an industrial accident in which three employees were severely burned.

Three workers were reported to have been troubleshooting electrical switchgear at the Cudahy, Wis., facility when electricity arched and exploded. OSHA's investigation revealed that the three workers, all of whom received first, second and third degree burns throughout their bodies, **were not using insulated tools, were not wearing proper personal protective equipment, and were not following appropriate safety standards. OSHA issued willful and serious violations to Cudahy for allegedly failing to provide such equipment, and warning or training the workers about flash hazards.**

"The Labor Department's significant fine of $148,500 sends a message that this Administration will enforce safety and health standards for workers," said U.S. Secretary of Labor Elaine L. Chao.



Safety Professionals & Unqualified workers (non electrical workers): Distance is our friend!

Qualified persons use a different approach!

LOTO
Electrical safety Related Work Practices
PPE (last resort)

"The standards require that all work shall be done deenergized"!

Part 1910
General Industry Standards

OSHA

NFPA
70E
Standard for Electrical Safety in the Workplace
Standard 2024

NFPA 70E

80 % of the electrically related accidents incidents and fatalities among *Qualified Workers*

Caused by

Arc Blast / Arc Flash

Effects of 60 Hz AC Current on the Human Body

1/1,000 Ampere = .001A = 1mA ≈ Perception level

1/100 Ampere = .01A = 10mA ≈ Muscular contraction
"Let Go" cannot release hand grip

3/100 Ampere = .03A = 30mA ≈ Lung Paralysis
"Respiratory Arrest"

7.5/100 Ampere = .075A = 75mA ≈ Possible
Ventricular Fibrillation .05%

¼ Ampere = .25A = 250 mA ≈ Fibrillation threshold – 99.5%

100 Watt Light Bulb
@ 120 Volts

Over ¾ Ampere

The power to light ONE light bulb is enough to fibrillate the heart of over 8 people SIMULTANOUSLY

Shock & Electrocution Levels

- 1/1000 Ampere (1mA) ≈ Perception level
- 1/100 Ampere (10mA) ≈ Muscular contraction
- 1/10 Ampere (100 mA) ≈ Electrocution

⇨ Does NOT trip until at least 15 amperes

Are these devices used to protect people ?

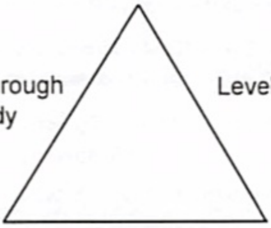
A. Yes.

B. No, They protect equipment & property.

Effects of 60 Hz AC Current on the Human Body

- 250 mA Fibrillation threshold – 99.5%
- 4 Amps Heart paralysis threshold
  - heart stops during current passage
- 5 – 20 Amps Tissue burning
- > 20 Amp Tissue and organ damage

Electrocution Triangle



Path Through Body

Level of Current

Time

110.4(A) Electrical Safety Training

Employees shall be trained to understand the specific hazards associated with electrical energy.

Employees shall be trained to identify and understand the relationship between electrical hazards and possible injury.

FACTS...

- 97% of all electricians have been shocked or injured on the job.
- Approximately 30,000 workers receive electrical shocks yearly.
- Over 3600 disabling electrical contact injuries occur annually.
- Electrocutions are the 4th leading cause of traumatic occupational fatalities.
- Over 2000 workers are sent to burn centers each year with severe Arc-Flash burns.
- Estimates show that 10 Arc-Flash incidents occur every day in the US.
- 60% of workplace accident deaths are caused by burn injuries.
- Over 1000 electrical workers die each year from workplace accidents.
- Medical costs per person can exceed $4 million for severe electrical burns.
- Total costs per electrical incident can exceed $15 million.

Information derived from Industry Surveys, the NFPA, The National Safety Council, Bureau of Labor Statistics, and CapSchell, Inc.

Electrical Hazards

Shock → Direct → Reaction — Electrocution, Falls

Burns

Fire

Explosions

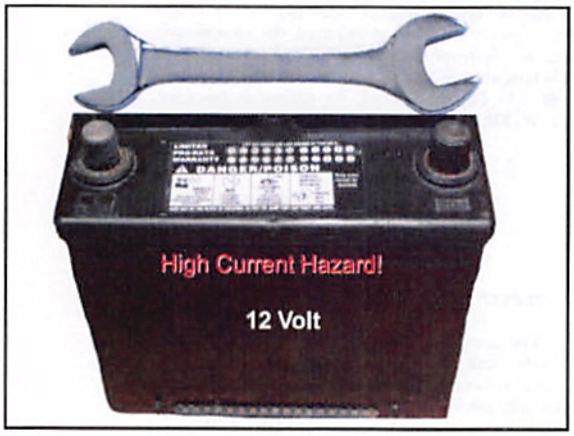
Arc Blast / Arc Flash

The Electrical Hazards - Identified NFPA 70E® (annex K)

Electric Shock

Arc-Blast

Arc-Flash



Electrical Hazards

Shock → Direct → Reaction — Electrocution, Falls

Burns

Fire

Explosions

Arc Blast / Arc Flash

High Current Hazard!

FACTS...

- 97% of all electricians have been shocked or injured on the job.
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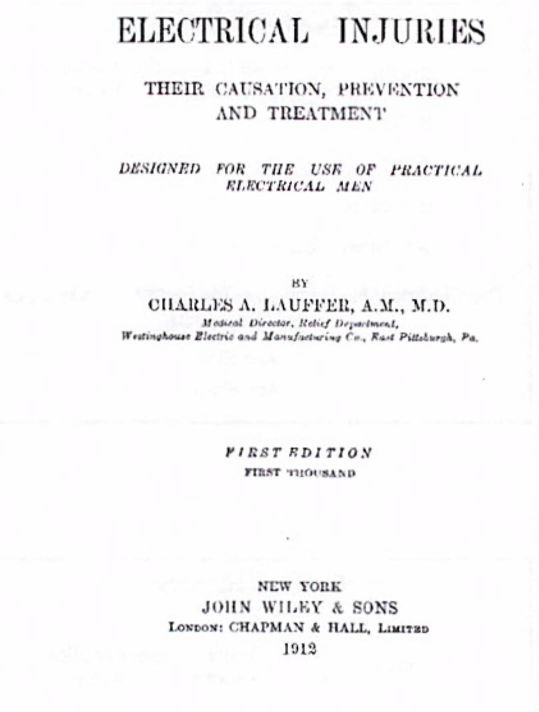


ELECTRICAL INJURIES

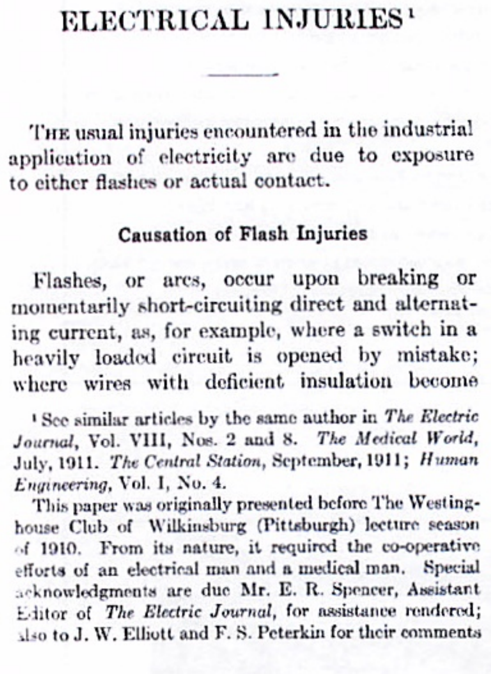
THEIR CAUSATION, PREVENTION
AND TREATMENT

*DESIGNED FOR THE USE OF PRACTICAL
ELECTRICAL MEN*

BY
CHARLES A. LAUFFER, A.M., M.D.
*Medical Director, Relief Department,
Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa.*

FIRST EDITION
FIRST THOUSAND

NEW YORK
JOHN WILEY & SONS
LONDON: CHAPMAN & HALL, LIMITED
1912



ELECTRICAL INJURIES[1]

THE usual injuries encountered in the industrial application of electricity are due to exposure to either flashes or actual contact.

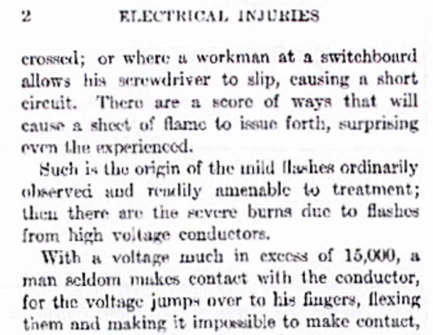
Causation of Flash Injuries

Flashes, or arcs, occur upon breaking or momentarily short-circuiting direct and alternating current, as, for example, where a switch in a heavily loaded circuit is opened by mistake; where wires with deficient insulation become

---

[1] See similar articles by the same author in *The Electric Journal*, Vol. VIII, Nos. 2 and 8. *The Medical World*, July, 1911. *The Central Station*, September, 1911; *Human Engineering*, Vol. I, No. 4.

This paper was originally presented before The Westinghouse Club of Wilkinsburg (Pittsburgh) lecture season of 1910. From its nature, it required the co-operative efforts of an electrical man and a medical man. Special acknowledgments are due Mr. E. R. Spencer, Assistant Editor of *The Electric Journal*, for assistance rendered; also to J. W. Elliott and F. S. Peterkin for their comments



crossed; or where a workman at a switchboard allows his screwdriver to slip, causing a short circuit. There are a score of ways that will cause a sheet of flame to issue forth, surprising even the experienced.

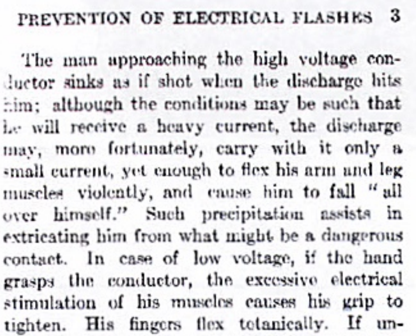
Such is the origin of the mild flashes ordinarily observed and readily amenable to treatment; then there are the severe burns due to flashes from high voltage conductors.

With a voltage much in excess of 15,000, a man seldom makes contact with the conductor, for the voltage jumps over to his fingers, flexing them and making it impossible to make contact, unless he is thrown upon it. It takes a man a perceptible interval of time to approach the conductor, but the discharge is instantaneous.

The flexor muscles are so much stronger than the extensors, that the man is rolled up and violently precipitated. The discharge that bridges the interval between the circuit and its victim may cause extensive surface burns, and to the extent that it spends its force on the surface, there is diminished liability of serious electrical shock.

and constructive criticisms; and to other electrical men for their suggestions and helpful criticisms.

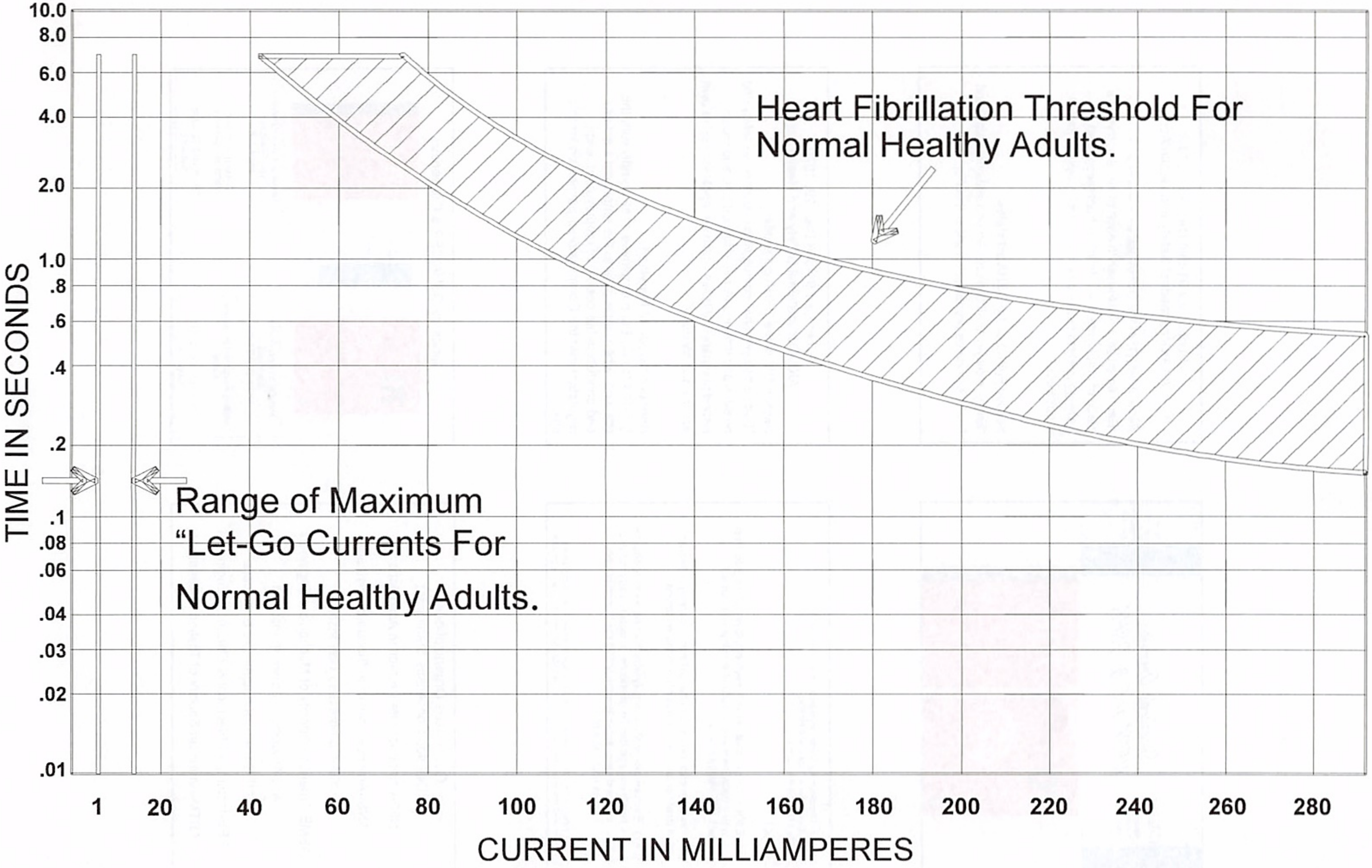
This work is as yet fragmentary; it is in the constructive stage; suggestions and comments, by way of addition or by way of subtraction, are invited by the author from all interested in this endeavor to outline the essential facts of electrical injuries.



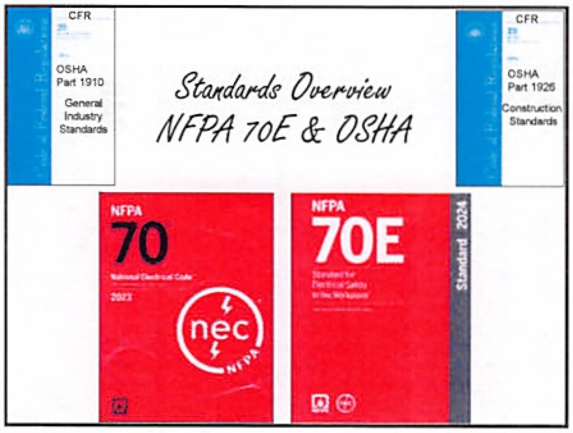
The man approaching the high voltage conductor sinks as if shot when the discharge hits him; although the conditions may be such that he will receive a heavy current, the discharge may, more fortunately, carry with it only a small current, yet enough to flex his arm and leg muscles violently, and cause him to fall "all over himself." Such precipitation assists in extricating him from what might be a dangerous contact. In case of low voltage, if the hand grasps the conductor, the excessive electrical stimulation of his muscles causes his grip to tighten. His fingers flex tetanically. If unassisted, he is often unable to release his hold.

Prevention of Electrical Flashes

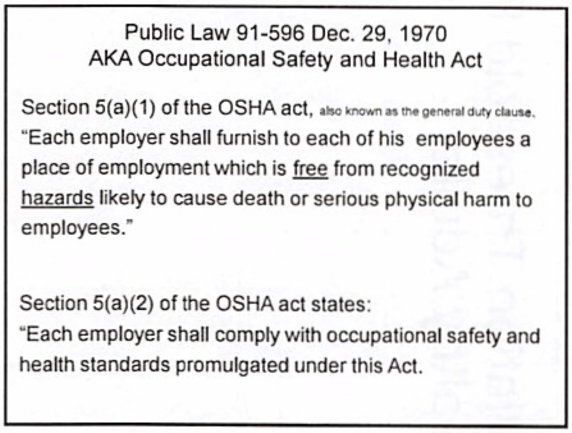
Careful attention in handling switches and plugs is imperative. Circuits should be open whenever practicable during tests and in repair work, and danger signs erected, as well as isolating the test by means of ropes. In the repairing of transmission lines and transformers connected thereto, the lines should be thoroughly grounded at the point of repair on any side from which power might be accidentally thrown on. Attention to such details as every electrical man knows, but sometimes ignores, will do much to minimize the number of these injuries. With sleeves rolled up to the elbows, and the face near a



Electrocution Curve



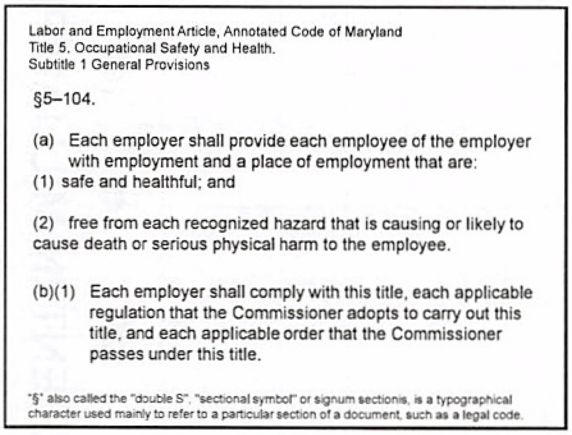
Standards Overview
NFPA 70E & OSHA



Public Law 91-596 Dec. 29, 1970
AKA Occupational Safety and Health Act

Section 5(a)(1) of the OSHA act, also known as the general duty clause. "Each employer shall furnish to each of his employees a place of employment which is free from recognized hazards likely to cause death or serious physical harm to employees."

Section 5(a)(2) of the OSHA act states:
"Each employer shall comply with occupational safety and health standards promulgated under this Act.



Labor and Employment Article, Annotated Code of Maryland
Title 5. Occupational Safety and Health.
Subtitle 1 General Provisions

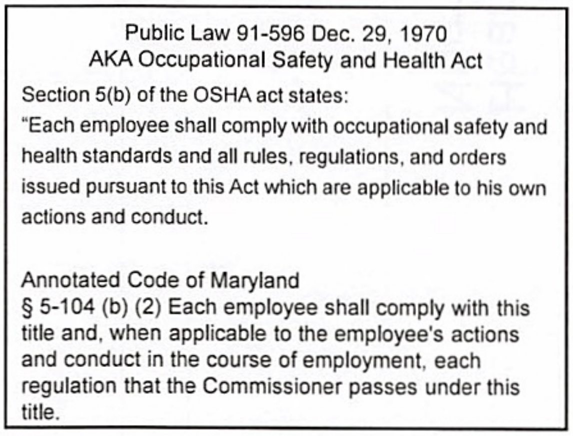
§5–104.

(a) Each employer shall provide each employee of the employer with employment and a place of employment that are:
(1) safe and healthful; and

(2) free from each recognized hazard that is causing or likely to cause death or serious physical harm to the employee.

(b)(1) Each employer shall comply with this title, each applicable regulation that the Commissioner adopts to carry out this title, and each applicable order that the Commissioner passes under this title.

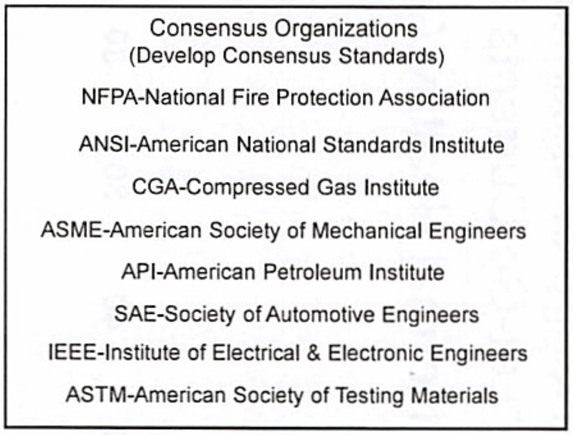
"§" also called the "double S", "sectional symbol" or signum sectionis, is a typographical character used mainly to refer to a particular section of a document, such as a legal code.



Public Law 91-596 Dec. 29, 1970
AKA Occupational Safety and Health Act

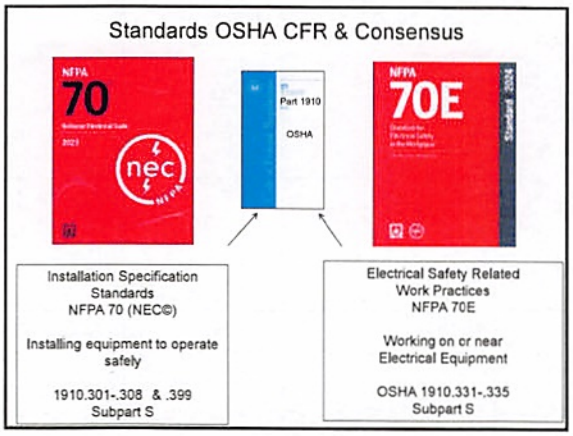
Section 5(b) of the OSHA act states:
"Each employee shall comply with occupational safety and health standards and all rules, regulations, and orders issued pursuant to this Act which are applicable to his own actions and conduct.

Annotated Code of Maryland
§ 5-104 (b) (2) Each employee shall comply with this title and, when applicable to the employee's actions and conduct in the course of employment, each regulation that the Commissioner passes under this title.



Consensus Organizations
(Develop Consensus Standards)

NFPA-National Fire Protection Association
ANSI-American National Standards Institute
CGA-Compressed Gas Institute
ASME-American Society of Mechanical Engineers
API-American Petroleum Institute
SAE-Society of Automotive Engineers
IEEE-Institute of Electrical & Electronic Engineers
ASTM-American Society of Testing Materials



Standards OSHA CFR & Consensus

Installation Specification
Standards
NFPA 70 (NEC©)

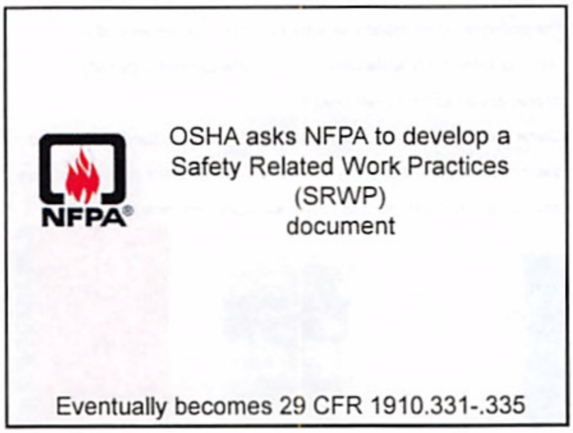
Installing equipment to operate safely

1910.301-.308 & .399
Subpart S

Electrical Safety Related
Work Practices
NFPA 70E

Working on or near
Electrical Equipment

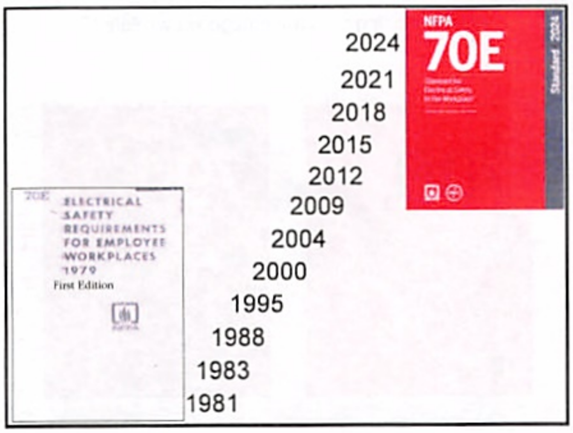
OSHA 1910.331-.335
Subpart S



NFPA®

OSHA asks NFPA to develop a Safety Related Work Practices (SRWP) document

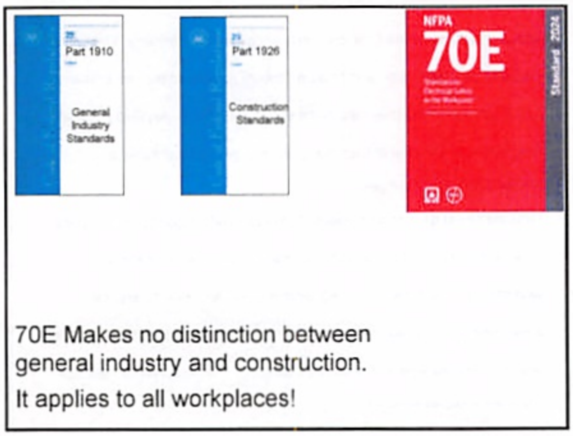
Eventually becomes 29 CFR 1910.331-.335



70E ELECTRICAL SAFETY REQUIREMENTS FOR EMPLOYEE WORKPLACES 1979
First Edition

NFPA 70E
Standard 2024

2024
2021
2018
2015
2012
2009
2004
2000
1995
1988
1983
1981



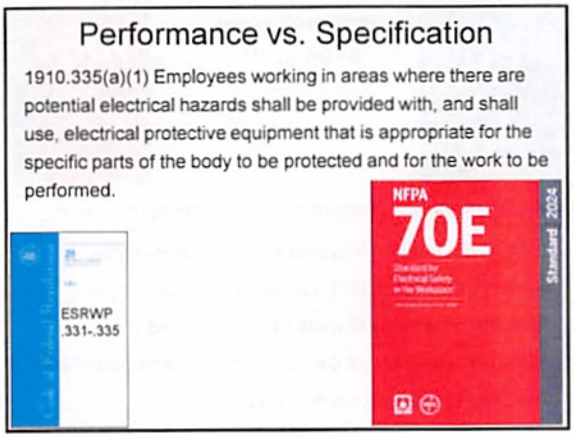
29 Part 1910 General Industry Standards

29 Part 1926 Construction Standards

NFPA 70E
Standard 2024

70E Makes no distinction between general industry and construction.

It applies to all workplaces!

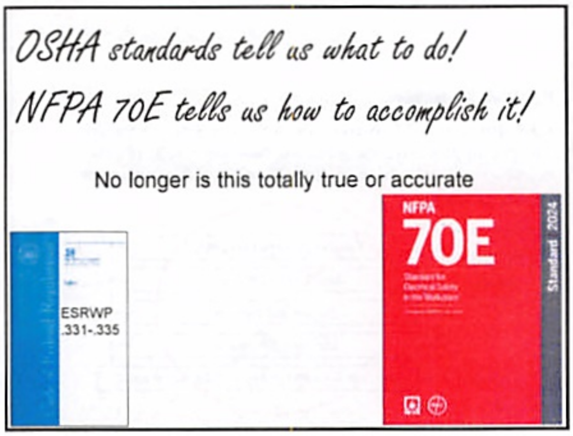


Performance vs. Specification

1910.335(a)(1) Employees working in areas where there are potential electrical hazards shall be provided with, and shall use, electrical protective equipment that is appropriate for the specific parts of the body to be protected and for the work to be performed.

ESRWP
.331-.335

NFPA 70E
Standard 2024



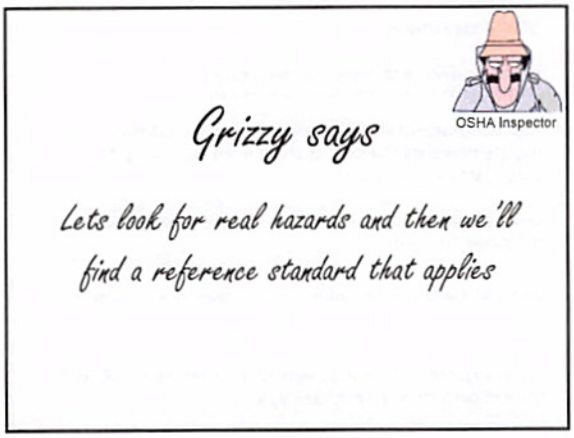
OSHA standards tell us what to do!

NFPA 70E tells us how to accomplish it!

No longer is this totally true or accurate

ESRWP
.331-.335

NFPA 70E
Standard 2024



Grizzy says

OSHA Inspector

Lets look for real hazards and then we'll find a reference standard that applies

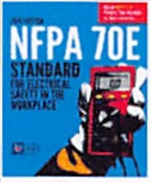
What's missing from the categories we listed?

NFPA
70B
Recommended Practice for Electrical Equipment Maintenance
NFPA
79
Electrical Standard for Industrial Machinery

For decades OSHA standards were historically characterized as minimum standards while consensus standards were generally characterized as best practices.

Some recent editions of consensus organization standards are turning that historical paradigm on its head and these consensus standards are now minimum standards and OSHA standards are now the pinnacle!

OSHA
Occupational
ANSI Z10
NFPA
70E
Standard 2024


NFPA 70E
STANDARD
FOR ELECTRICAL SAFETY IN THE WORKPLACE

Significant Changes
Began in 2015

NFPA
70E
Standard 2024

Hazard Analysis Changed to Risk Assessment (Annex F)

Risk Assessment. An overall process that identifies hazards, estimates the potential severity of injury or damage to health, **estimates the likelihood** of occurrence of injury or damage to health, and determines if protective measures are required.

Actuaries analyze the financial costs of risk and uncertainty. They use mathematics, statistics, and financial theory to assess the risk that an event will occur and they help businesses and clients develop policies that minimize the cost of that risk. (from US Bureau of Labor Statistics Occupational Outlook handbook)

Occupational Safety and Health Professionals analyze many types of work environments and work procedures. Specialists inspect workplaces for adherence to regulations on safety, health, and the environment. They also design programs to prevent disease or injury to workers and damage to the environment. (from US Bureau of Labor Statistics Occupational Outlook handbook)

"Risk Assessment":

Is junk science and doesn't ensure safety
(the people who wrote this into our standards said so)

Risk assessment would be a violation of the OSHA requirements/standards and could even set you up for potential "willful" citations

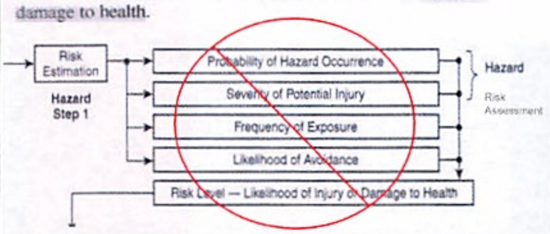
JHA's & JSA's to eliminate hazards is hazard analysis & what we should be doing.

Latter we'll address the problem with "*conformity assessment*"

We will ignore all "*risk assessment*" references in 70E and instead perform a "*hazard analysis*"

F.3 Risk Reduction.

F.3.1 Protective Measures. Once the risk prior to the application of protective measures has been estimated, all practicable efforts must be made to reduce the risk of injury or damage to health.


Risk Estimation
Hazard Step 1
Probability of Hazard Occurrence
Severity of Potential Injury
Frequency of Exposure
Likelihood of Avoidance
Risk Level — Likelihood of Injury or Damage to Health
Hazard
Risk Assessment

Assess risk by estimating to reduce the injury?????
(Assess & minimize)

WHAT?????

How about analyze (JSA/JHA) to prevent injury!!!
(Analyze and eliminate)

Remember – "nobody should be getting hurt" not even a little bit

The goal/objective of an Occupational Safety & Health Professional is to send everyone home at the end of the workday uninjured and exactly the same as they arrived for work in the morning! We don't want to hear about risk assessment!

We don't estimate and gamble with peoples lives or peoples health and safety! (not even a little bit)

Where did this risk assessment approach come from?

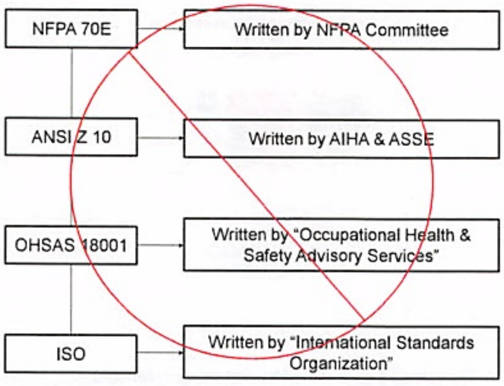
Committee members have informed me that it's a result of Harmonization.

Foreign overseas standards – (BS 18001, ISO 9001, 14001)

This is NOT Harmonization, this is Globalism

Although these are frequently compared to OSHA's S&H program guidelines (published 1989) & I2P2 (injury & illness prevention program), they are NOT the same as risk assessment.

- Management commitment and employee involvement
- Worksite analysis
- Hazard prevention and control
- Safety and health training



NFPA 70E → Written by NFPA Committee

ANSI Z 10 → Written by AIHA & ASSE

OHSAS 18001 → Written by "Occupational Health & Safety Advisory Services"

ISO → Written by "International Standards Organization"

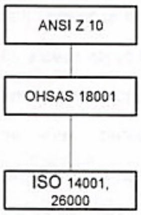
Z10-2012 - Standard for Occupational Health & Safety Management Systems

ANSI Z10 E6.4B: "Risk cannot be eliminated entirely, though it can be substantially reduced"

ANSI Z10 Appendix F: "No single risk assessment technique will apply in all situations". An organization will need to select an appropriate risk assessment technique for the task, hazard, equipment or process to be assessed."

ANSI Z10 Appendix F: **"It should be noted that the science behind determining the relationships between hazard, exposure and risk has not sufficiently evolved to be precise or predictive."**

This new requirement in 70E is a result of "Harmonization"
"Globalization"

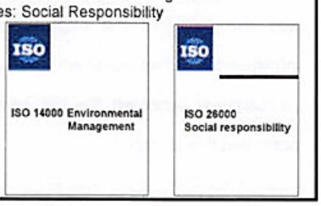


ANSI Z 10

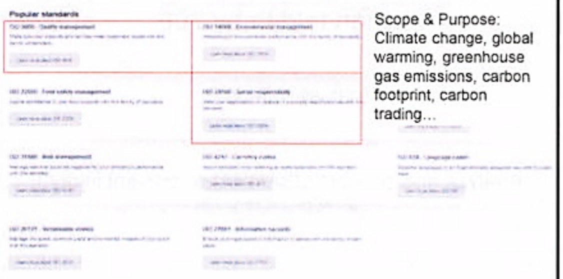
OHSAS 18001

ISO 14001, 26000

14000 series: Environmental Management
26000 series: Social Responsibility

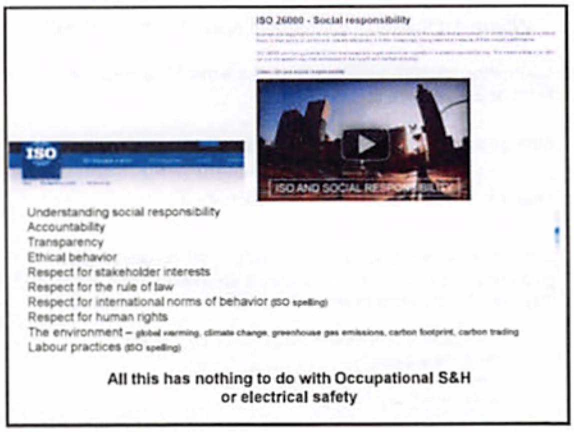


ANSI Z10 linked to ISO 9001, ISO14001, & 26000.
OHSAS based their 18001 on these ISO standards.



Scope & Purpose:
Climate change, global warming, greenhouse gas emissions, carbon footprint, carbon trading...

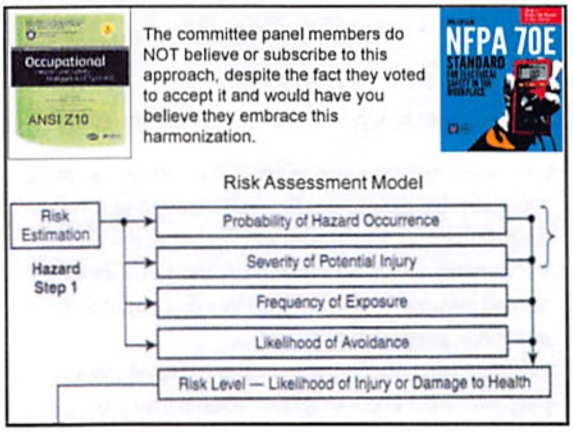
*ISO 14001 focuses on managing your organization's impact on the external environment, to reduce pollution and comply with regulations.



ISO 26000 - Social responsibility

Understanding social responsibility
Accountability
Transparency
Ethical behavior
Respect for stakeholder interests
Respect for the rule of law
Respect for international norms of behavior (ISO spelling)
Respect for human rights
The environment – global warming, climate change, greenhouse gas emissions, carbon footprint, carbon trading
Labour practices (ISO spelling)

All this has nothing to do with Occupational S&H or electrical safety



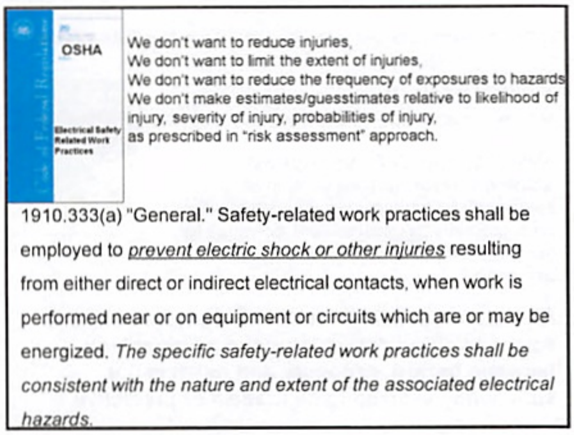
The committee panel members do NOT believe or subscribe to this approach, despite the fact they voted to accept it and would have you believe they embrace this harmonization.

Risk Assessment Model

Risk Estimation

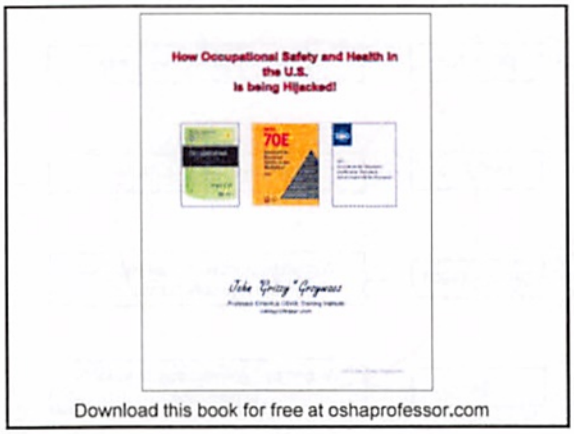
Hazard Step 1

Probability of Hazard Occurrence
Severity of Potential Injury
Frequency of Exposure
Likelihood of Avoidance
Risk Level — Likelihood of Injury or Damage to Health


OSHA
Electrical Safety Related Work Practices

We don't want to reduce injuries,
We don't want to limit the extent of injuries,
We don't want to reduce the frequency of exposures to hazards
We don't make estimates/guesstimates relative to likelihood of injury, severity of injury, probabilities of injury,
as prescribed in "risk assessment" approach.

1910.333(a) "General." Safety-related work practices shall be employed to prevent electric shock or other injuries resulting from either direct or indirect electrical contacts, when work is performed near or on equipment or circuits which are or may be energized. *The specific safety-related work practices shall be consistent with the nature and extent of the associated electrical hazards.*



How Occupational Safety and Health in the U.S. is being Hijacked!

Download this book for free at oshaprofessor.com

We will not conduct Risk Assessments when told to by 70E

What we will do is:

Analyze and conduct (JSA/JHA) to prevent injury!!!
(Analyze and eliminate)

Risk assessments are not a legally recognized affirmative defense and subject to citation (potentially willful?.

We conducted the *risk assessment* (per 70E) and *estimated* that it was *probably unlikely* that the injuries would be as severe as they were (or acceptable as sustained) and concluded (per the risk assessment) that the injuries sustained were an acceptable level of risk. Also included in the risk assessments was the fact that the exposure frequency was extremely infrequent. In other words we *knew what the hazards were* and *calculatingly* accepted the risk level (per 70E & ANSI Z10) and permitted this to occur.

70E Consists of 3 Chapters and 18 Annexes

Article 90 Introduction

Chapter 1 Safety Related Work Practices

100 Definitions
105 Application of Safety Related Work Practices
110 General Requirements
120 Establishing an Electrically Safe Work Condition
130 Work Involving Electrical Hazards

Chapter 1 will be the concentration for this course

2024 Changes are indicated:

(See 1st page inside front cover)

Shaded text = Revisions.

Δ = Text deletions and revisions and figure/table revisions.

● = Section deletions.

N = New material.

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document.

Let's look at Article 100

What's an AHJ?

The AHJ is responsible for enforcing requirements of a code or standard.

The AHJ is responsible for interpreting the code.
[NFPA 70 Handbook Article 90.4 Enforcement]

A. Informative Publications
B. (reserved)
C. Limits of Approach
D. Incident Energy & Arc Flash Boundary Calculation Methods
E. Electrical Safety Program
F. Risk Assessment and Risk Control
G. Sample LOTO Procedure
H. Guidance and Selection of PPE
I. Job Briefing and Planning Checklist
J. Energized Electrical Work Permit (EEWP)
K. General Categories of Electrical hazards
L. Application of Safeguards in the Cell Line Working Zone
M. Layering PPE and Total System Arc Rating
N. Examples of Procedures for Working Near Overhead Lines
O. Safety Related Design requirements
P. Aligning Implementation of 70E with Occupational Health and Safety Management Standards.
Q. Human Performance and Workplace Electrical Safety
R. Capacitors

Another consensus Standard
IEEE 1584
Guide for performing Arc Flash Hazard Calculations

- IEEE 1584
  Guide for Performing Arc-Flash Hazard Calculations

IEEE Standards

1584™

IEEE Guide for Performing Arc-Flash Hazard Calculations

IEEE Industry Applications Society

IEEE

This is important

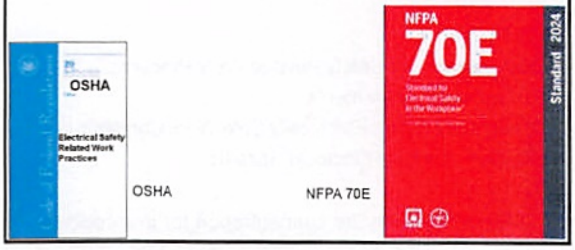
All these Standards

WOW!

NFPA 70E, OSHA
and You:
Insight for Implementation

The moral of the story....

When working on or near electricity or electrical equipment you must be trained in & use Electrical Safety Related Work Practices



OSHA

NFPA 70E

Electrical Hazards

Shock → Direct → Reaction

Electrocution
Falls

Burns

Fire

Explosions

Arc Blast / Arc Flash

High Current Hazard

Article 90 – Introduction

Δ 90.1 Scope. This article covers the use, application, and arrangement of this standard.

90.2 Purpose. The purpose of this standard is to provide a practical safe working area for employees relative to the hazards arising from electricity.

90.3 Workplaces Covered and Not Covered.

(A) Workplaces Covered. This standard addresses electrical safety –related work practices, safety related maintenance requirements, and other administrative controls for employee workplaces that are *necessary* for the practical safeguarding of employees relative to the hazards associated with electrical energy during activities such as the installation, removal, inspection, operation, maintenance, and demolition of electric conductors, electric equipment, signaling and communications conductors and equipment, and raceways.

Who does these activities?

90.3 Workplaces Covered and Not Covered.

(A) Workplaces Covered.

(B) This standard also includes safe work practices for employees performing other work activities that can expose them to electrical hazards as well as safe work practices for the following:

(1) Installations of conductors and equipment that connect to the supply of electricity.

(2) Installations used by the electric utility, such as office buildings, warehouses, garages, machine shops, and recreational buildings that are not an integral part of a generating plant, substation or control center.

Article 90 – Introduction

90.3(B) Not Covered. This standard does not cover:

Watercraft & Railways…

Railways supply…

Installations exclusive to communications utilities

Installations exclusive to electric power utilities

No electrical hazards?

Δ Article 100 Definitions

Scope. This article contains only those definitions essential to the proper application of this standard. It is not intended to include commonly defined general terms or commonly defined technical terms from related codes and standards. ~~In general, only those terms that are used in **two or more articles** are defined in article 100.~~ An article number in parentheses following the definition indicates the definition applies to that article.

Δ Article 100 – Definitions

- Equipment. A general term, including material, fittings, *devices, appliances, luminaires, apparatus, machinery, and the like* used as a part of, or in connection with, an electrical installation.

Do only qualified persons use electrical equipment?

What is an "unqualified" person?

Training Requirements

110.4(A)(2) Unqualified Persons. *Shall* be trained in, and be familiar with, any electrical safety-related work practices necessary for their safety.

Training Requirements

Δ 110.4(A) Electrical Safety Training

"Such employees shall be trained to understand the specific hazards associated with electrical energy."

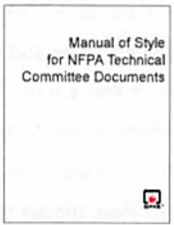
Δ110.4(A)(1) Qualified Person. *Shall* be trained to identify and avoid electrical hazards that might be present with respect to that equipment or work method.

Article 90 – Introduction

90.3 Standard Arrangement.

90.4 Mandatory Rules, Permissive Rule, and Explanatory Material.

Chapter 1 Document Structure
1.1 General
1.2 Document Types
1.3 Performance-Based Documents
1.4 Document Division
1.5 Front Matter
1.6 Administrative Chapters
1.7 Individual Chapter Administrative Text
1.8 Numbering System
1.9 Annexes
1.10 Index
1.11 Codes and Standards Pages
Chapter 2 Technical Style
2.1 General
2.2 Technical Rules
2.3 Rules for Mandatory Documents
2.4 Rules for Nonmandatory Documents
2.5 Internationalization of Documents
2.6 Extracts
Chapter 3 Editorial Style
3.1 General
3.2 Text Editorial Rules
3.3 Document Structure Editorial Rules
3.4 Material from Other Organizations
3.5 Explanatory Information
3.6 References
3.7 Special Elements
3.8 Annexes
3.9 Vertical Rules and Bullets
Chapter 4 Units of Measurement


Manual of Style
for NFPA Technical
Committee Documents

Article 105 Application of Safety-Related Work Practices and Procedures

Δ105.1 Scope. This article covers the application of electrical-safety related work practices and procedures for *employees* who are exposed to an electrical hazard in workplaces covered in 90.3.

Δ105.2 Purpose. These practices and procedures are intended to provide for employee safety relative to electrical hazards in the workplace.

See Informative Annex K for general categories of electrical hazards.

Article 105 Application of Safety-Related Work Practices

105.3 (A) Employer Responsibility.

105.3 (B) Employee Responsibility.

So, who has responsibilities under this standard?

Who's responsible for your safety?

Whose responsibility is your safety?

Can your safety practices affect others?

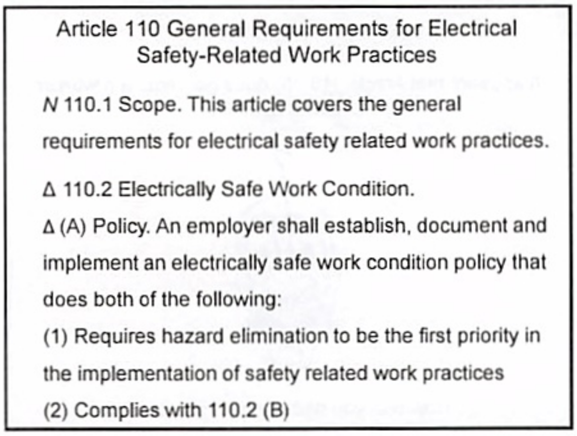
Many of the things we talk about today will require changes in your thinking...you must WANT to do this for YOUR well-being...

Did you hear what he said he does differently now?

Whose responsibility is your safety?

What if you were working next to this guy?

Can your safety practices affect others?



Article 110 General Requirements for Electrical Safety-Related Work Practices

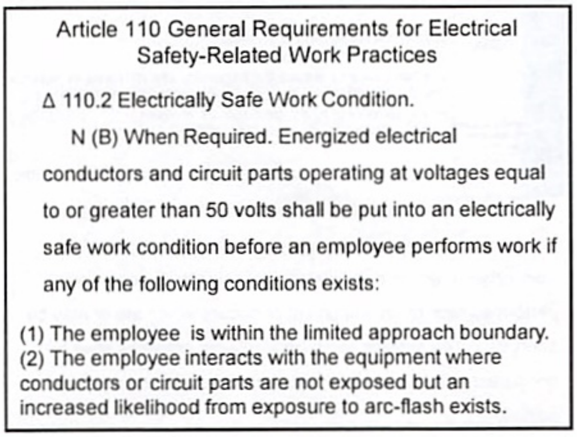
N 110.1 Scope. This article covers the general requirements for electrical safety related work practices.

Δ 110.2 Electrically Safe Work Condition.

Δ (A) Policy. An employer shall establish, document and implement an electrically safe work condition policy that does both of the following:

(1) Requires hazard elimination to be the first priority in the implementation of safety related work practices

(2) Complies with 110.2 (B)

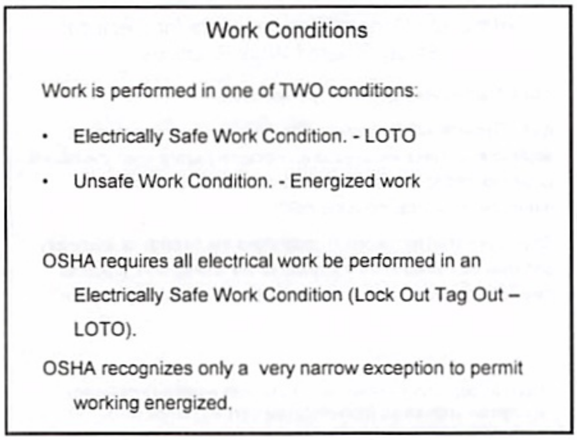


Article 110 General Requirements for Electrical Safety-Related Work Practices

Δ 110.2 Electrically Safe Work Condition.

N (B) When Required. Energized electrical conductors and circuit parts operating at voltages equal to or greater than 50 volts shall be put into an electrically safe work condition before an employee performs work if any of the following conditions exists:

(1) The employee is within the limited approach boundary.
(2) The employee interacts with the equipment where conductors or circuit parts are not exposed but an increased likelihood from exposure to arc-flash exists.



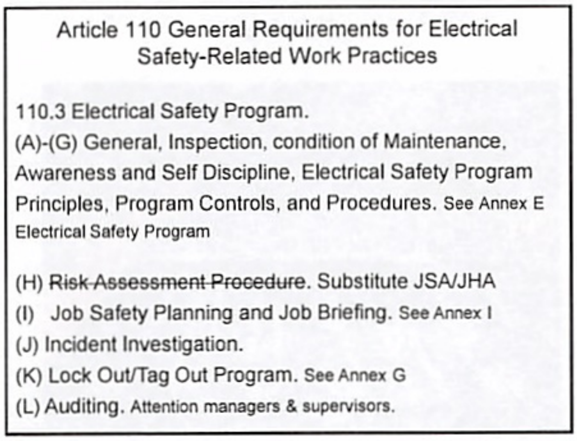
Work Conditions

Work is performed in one of TWO conditions:

- Electrically Safe Work Condition. - LOTO
- Unsafe Work Condition. - Energized work

OSHA requires all electrical work be performed in an Electrically Safe Work Condition (Lock Out Tag Out – LOTO).

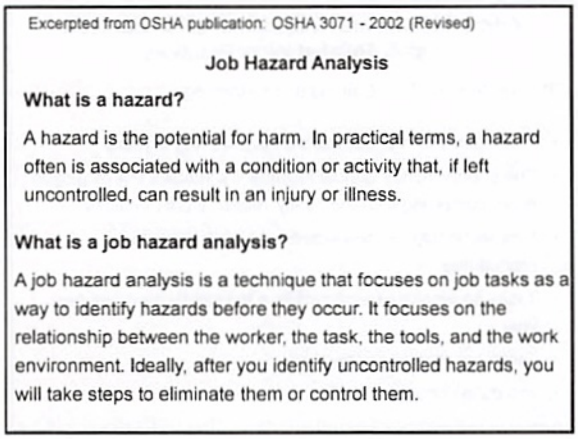
OSHA recognizes only a very narrow exception to permit working energized.



Article 110 General Requirements for Electrical Safety-Related Work Practices

110.3 Electrical Safety Program.
(A)-(G) General, Inspection, condition of Maintenance, Awareness and Self Discipline, Electrical Safety Program Principles, Program Controls, and Procedures. See Annex E Electrical Safety Program

(H) ~~Risk Assessment Procedure~~. Substitute JSA/JHA
(I) Job Safety Planning and Job Briefing. See Annex I
(J) Incident Investigation.
(K) Lock Out/Tag Out Program. See Annex G
(L) Auditing. Attention managers & supervisors.



Excerpted from OSHA publication: OSHA 3071 - 2002 (Revised)

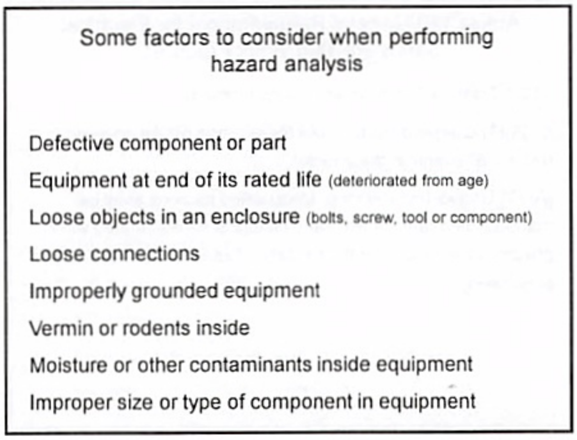
Job Hazard Analysis

What is a hazard?

A hazard is the potential for harm. In practical terms, a hazard often is associated with a condition or activity that, if left uncontrolled, can result in an injury or illness.

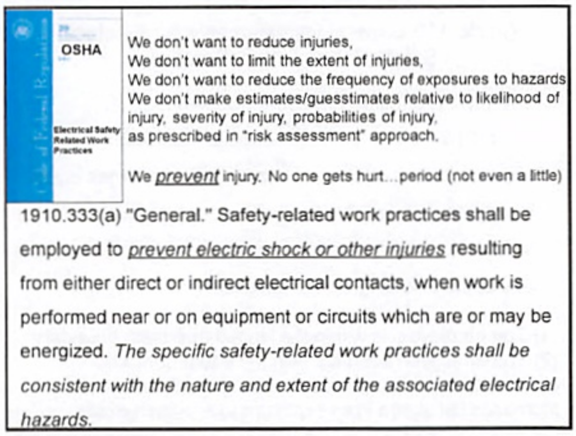
What is a job hazard analysis?

A job hazard analysis is a technique that focuses on job tasks as a way to identify hazards before they occur. It focuses on the relationship between the worker, the task, the tools, and the work environment. Ideally, after you identify uncontrolled hazards, you will take steps to eliminate them or control them.



Some factors to consider when performing hazard analysis

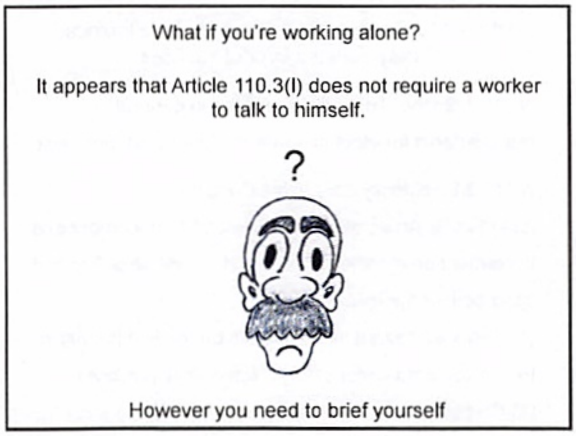
Defective component or part
Equipment at end of its rated life (deteriorated from age)
Loose objects in an enclosure (bolts, screw, tool or component)
Loose connections
Improperly grounded equipment
Vermin or rodents inside
Moisture or other contaminants inside equipment
Improper size or type of component in equipment


OSHA
Electrical Safety Related Work Practices

We don't want to reduce injuries,
We don't want to limit the extent of injuries,
We don't want to reduce the frequency of exposures to hazards
We don't make estimates/guesstimates relative to likelihood of injury, severity of injury, probabilities of injury,
as prescribed in "risk assessment" approach.

We *prevent* injury. No one gets hurt…period (not even a little)

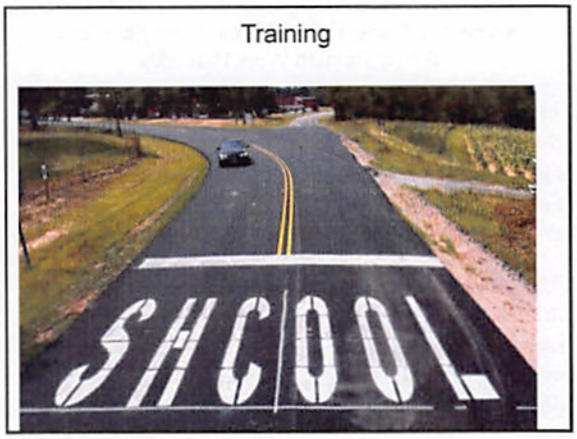
1910.333(a) "General." Safety-related work practices shall be employed to *prevent electric shock or other injuries* resulting from either direct or indirect electrical contacts, when work is performed near or on equipment or circuits which are or may be energized. *The specific safety-related work practices shall be consistent with the nature and extent of the associated electrical hazards.*



What if you're working alone?

It appears that Article 110.3(I) does not require a worker to talk to himself.

However you need to brief yourself



Training

Article 110 General Requirements for Electrical Safety-Related Work Practices

110.4 Training Requirements (paraphrased)

Δ (A) Electrical safety Training. The Training requirements shall apply to employees exposed to an electrical hazard when the hazard is not reduced to a safe level by the installation specification requirements (contained in the NEC).

Employees shall be trained to understand the hazards of electricity and shall be trained in the electrical safety related work practices they need to protect themselves based on the work they perform.

Don't forget: This standard applies to both qualified employees, as well as unqualified (non-electrical workers) employees

Article 110 General Requirements for Electrical Safety-Related Work Practices

110.4 Training Requirements (paraphrased)

Δ (A)(1) Qualified Person. *(All these items will be covered in detail a little later in the course).*

(A) (2) Unqualified Persons. Unqualified persons shall be trained in and familiar with, any electrical safety-related work practices necessary for their safety. *(Explained with examples stay tuned)*

Article 110 General Requirements for Electrical Safety-Related Work Practices

110.4(A)(3) Additional Training and Retraining.

- Trained in the 70E Standard changes every 3 years
- The supervision or annual inspections indicate the employee is not complying with the safety-related work practices.
- New technologies, new equipment or changes in procedures.
- Tasks an employee performs less frequently than one per year.
- Tasks not normally performed.
- Job duties change.

Article 110 General Requirements for Electrical Safety-Related Work Practices

110.4(A)(5) – Training Documentation. The employer shall document that each employee has received the training required by 110.4(A). This documentation shall be made in accordance with the following:

(1) Be made when the employee demonstrates proficiency in the work practices involved

(2) Be retained for the duration of the employee's employment

(3) Contain the content of the training, each employee's name, and dates of training

Article 110 General Requirements for Electrical Safety-Related Work Practices

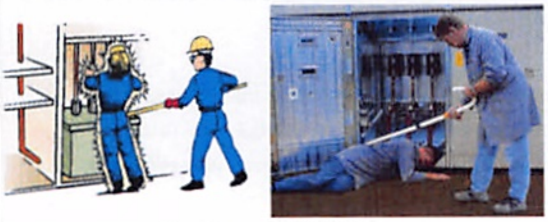
110.4(B) Lockout/Tagout Procedure Training.

110.4(C) Emergency Response Training.

110.4(C)(1) Contact Release. Employees exposed to shock hazards and those responsible for the safe release of victims from contact with energized electrical conductors or circuit parts shall be trained in methods of safe release. Refresher training shall occur annually.

Article 110.4(C) Emergency Procedures

110.6(C)(1) Contact release. Contact Release. Employees exposed to shock hazards and those responsible for the safe release of victims from contact with energized electrical conductors or circuit parts shall be trained in methods of safe release. Refresher training shall occur annually.



What's wrong with this?

Article 110 General Requirements for Electrical Safety-Related Work Practices

110.4(C)(2) First Aid, Emergency Response, and Resuscitation

(a) Employees responsible for responding to medical emergencies shall be trained in first aid and emergency procedures.

(b) CPR training.

(c) AED use (if the emergency response plan calls for the use of this device).

(d) Training shall occur at a frequency that satisfies the requirements of the certifying body.

Article 110 General Requirements for Electrical Safety-Related Work Practices

110.5 Host and Contract Employers' Responsibilities.

(A) Host Employer Responsibilities.

(1) The host employer shall inform contract employees of the following:

(1) Known hazards that are covered by this standard, that are related to the contract employer's work, and that might not be recognized by the contract employer or its employees

(2) Information about the employer's installation that the contract employer needs to make the assessments required by Chapter 1

The host employer shall report observed contract employer–related violations of this standard to the contract Employer.

(B) Contract Employer Responsibilities.

(1) The contract employer shall ensure that each of his or her employees is instructed in the hazards communicated to the contract employer by the host employer. This instruction shall be in addition to the basic training required by this standard.

(2) The contract employer shall ensure that each of his or her employees follows the work practices required by this standard and safety-related work rules required by the host employer.

(3) The contract employer shall advise the host employer of the following:

(1) Any unique hazards presented by the contract employer's work

(2) Hazards identified during the course of work by the contract employer that were not communicated by the host employer

(3) The measures the contractor took to correct any violations reported by the host employer under 110.3(A)(2) and to prevent such violation from recurring in the future

110.5(C) Documentation

Where the host employer has knowledge of hazards covered by this standard that are related to the contract employers work, there shall be a documented meeting between the host employer and the contract employer.

Some Suggested Discussion Items and/or request:

- Electrical Safety Program.
- Electrical contractor employees trained in 70E? (edition?)
- LOTO program(s).
- Any expected energized work on the project?
- If so what, when, why?
- Copy of energized electrical work permit (EEWP) form.
- All electrical workers have and expected to use electrical PPE? What electrical PPE has been issued to them?
- How do they determine approach distances to exposed live parts per the "approach boundaries". (for shock/electrocution protection)
- How do they conduct the arc flash hazard analysis required and determine the flash boundary?
- Procedures for "alerting techniques" and exposure control for unqualified personnel?

110.4 Training Requirements

Δ (A) The training requirements contained in 110.4(A) shall apply to employees exposed to an electrical hazard when the risk associated with that hazard is not reduced to a safe level by the applicable electrical installation requirements.

110.4(A)(2) **Unqualified Persons.** Unqualified persons shall be trained in and familiar with, any electrical safety-related practices necessary for their safety.

OSHA 1910.332(a)

Scope. The training requirements contained in this section apply to employees who face a risk of electric shock that is not reduced to a safe level by the electrical installation requirements of 1910.303 through 1910.308.

1910.332(b)(1) Employees shall be trained in and familiar with the safety-related work practices required by 1910.331 through 1910.335 that pertain to their respective job assignments.

"not reduced to a safe level by the electrical installation requirements" of the Installation Specification Standards

OSHA's
Installation Specification
Electrical Standards
1910.301-.308

NFPA
70
National Electrical Code
2023
nec
NFPA

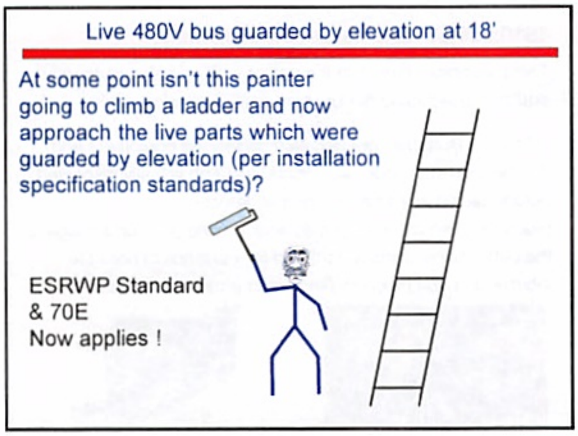
Broad Categories of Protection by Electrical Installation Specification Standards

These are installation specifications
Contained in the NEC®, & OSHA 1910.301-308

1 - Avoid Contact
    a - Isolate (guard, enclose)
    b - Insulate
    c - Elevate NEC 110.27 Guarding elevation

2 - Grounding (equipment grounding conductor)

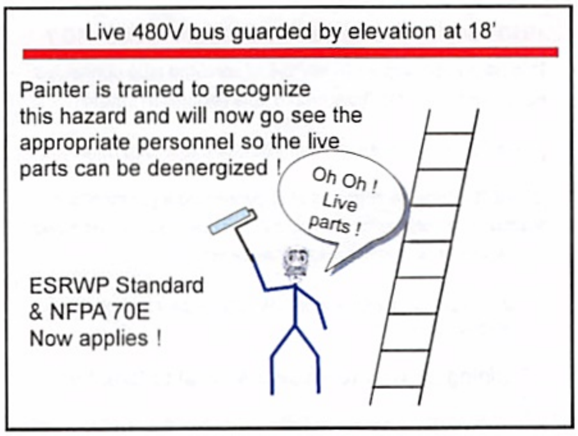
3 - GFCI (Ground Fault Circuit Interrupters)



Live 480V bus guarded by elevation at 18'

At some point isn't this painter going to climb a ladder and now approach the live parts which were guarded by elevation (per installation specification standards)?

ESRWP Standard
& 70E
Now applies !



Live 480V bus guarded by elevation at 18'

Painter is trained to recognize this hazard and will now go see the appropriate personnel so the live parts can be deenergized !

Oh Oh ! Live Parts !

ESRWP Standard
& NFPA 70E
Now applies !

Unqualified Workers (non electrical workers)

Are normally protected by the installation requirements by Subpart S and the NEC®.

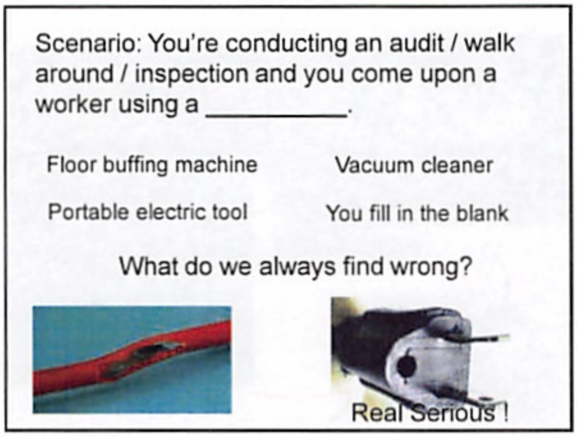
However

If their work exposes them to electrical hazards which would otherwise be protected according to Subpart S and the NEC® - they must be *trained.*

Trained to recognize and avoid hazards encountered or likely to encounter while working!

The majority of electrically related accidents, incidents and fatalities among *unqualified* (non-electrical) workers is shock / electrocution!

The primary causal factors are lack of appropriate training, lack of equipment grounding, lack of GFCI !

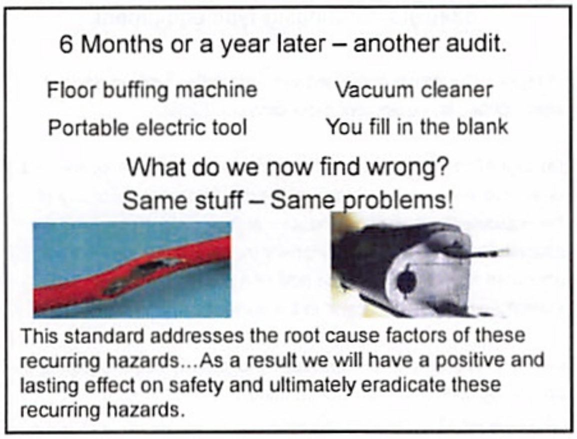


Scenario: You're conducting an audit / walk around / inspection and you come upon a worker using a __________.

Floor buffing machine	Vacuum cleaner
Portable electric tool	You fill in the blank

What do we always find wrong?

Real Serious !



6 Months or a year later – another audit.

Floor buffing machine	Vacuum cleaner
Portable electric tool	You fill in the blank

What do we now find wrong?
Same stuff – Same problems!

This standard addresses the root cause factors of these recurring hazards…As a result we will have a positive and lasting effect on safety and ultimately eradicate these recurring hazards.

1910.334(a) Portable electric equipment. 70E 110.7

This paragraph applies to the use of cord and plug connected equipment including flexible cord sets (extension cords).

.334(a)(1) Don't abuse it mishandle it or use it for a rope.

.334(a)(2) Portable cord and plug connected equipment and flexible cord sets (extension cords) *shall* be visually inspected before use on any shift for external defects...

> *If we expect employees to "visually inspect before use" what must we do?*

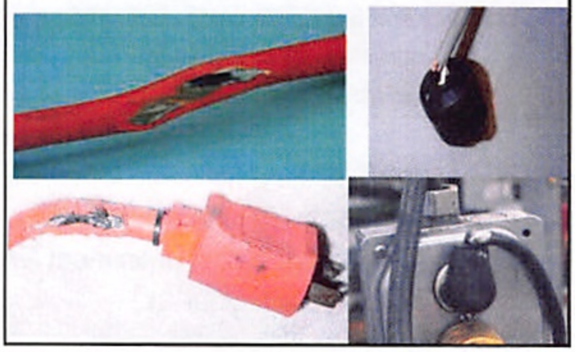
Training on how to inspect & what to look for!

1910.334(a) Portable electric equipment.

This paragraph applies to the use of cord and plug connected equipment including flexible cord sets (extension cords).

.334(a)(2) Portable cord and plug connected equipment and flexible cord sets (extension cords) *shall* be visually inspected before use on any shift for external defects...
(such as loose parts, deformed and missing pins, or damage to the outer jacket or insulation) and for evidence of possible internal damage (such as pinched or crushed outer jacket).

.334(a)(2) Visual Inspection.



.334(a)(2)(ii) Use of portable equipment

- If there is a defect or evidence of damage that might expose an employee to injury, the defective or damaged item shall be removed from service and no employee may use it until repairs and tests necessary to render the equipment safe have been made.

If we expect employees to "remove something from service" what do we need to?

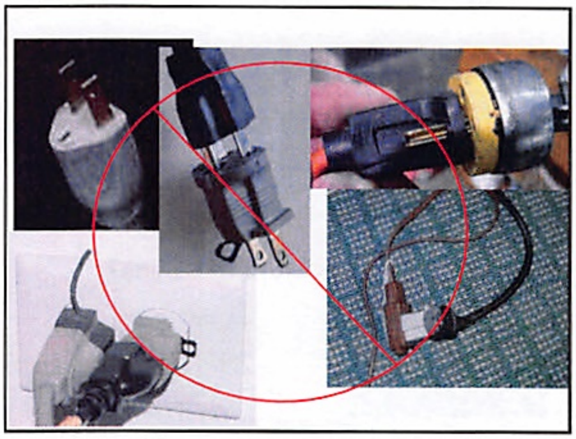
____

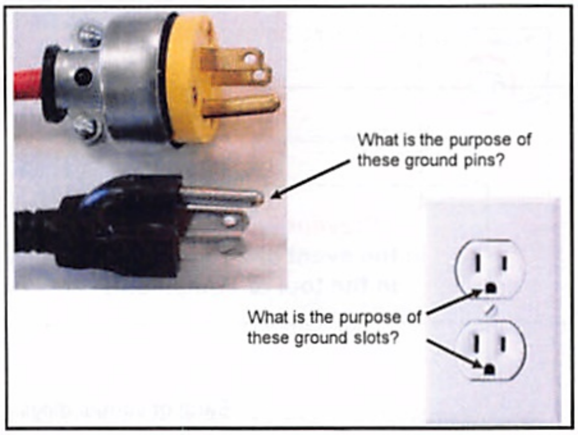
.334(a)(3) Grounding-type equipment.

.334(a)(3)(i) Flexible cord used with grounding type equipment shall contain an equipment grounding conductor.

(a)(3)(ii)Attachment plugs and receptacles may not be connected or altered in a manner which would prevent proper continuity of the equipment grounding conductor at the point where plugs are attached to receptacles. Additionally these devices may not be altered to allow the grounding pole of a plug to be inserted into slots intended for connection to the current carrying conductors.

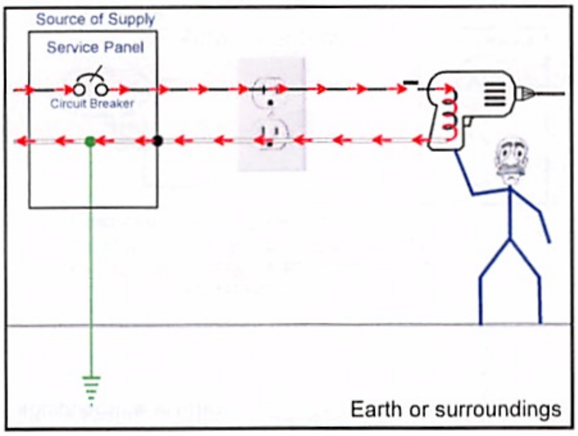
(a)(3)(iii) Adapters which interrupt the continuity of the equipment grounding conductor may not be used.

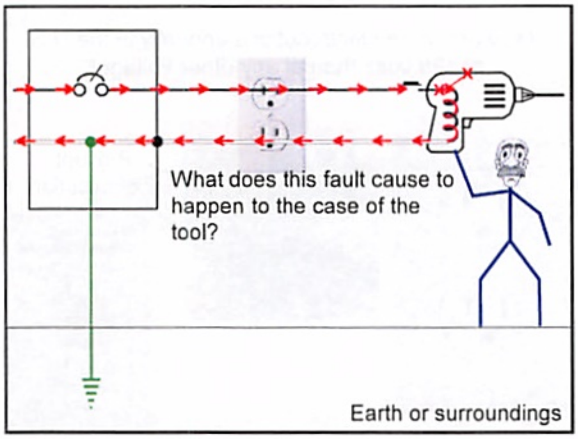




What is the purpose of these ground pins?

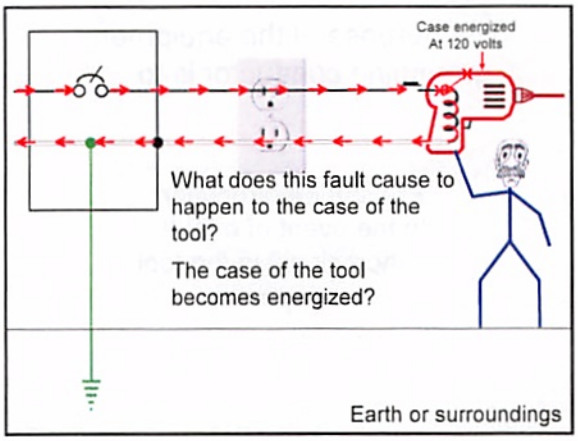
What is the purpose of these ground slots?


Source of Supply
Service Panel
Circuit Breaker
Earth or surroundings



What does this fault cause to happen to the case of the tool?

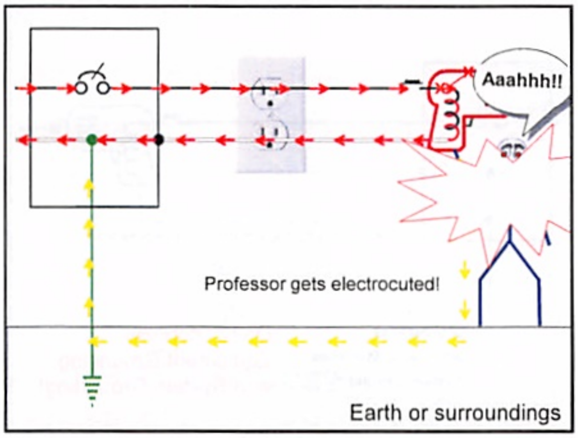
Earth or surroundings



What does this fault cause to happen to the case of the tool?

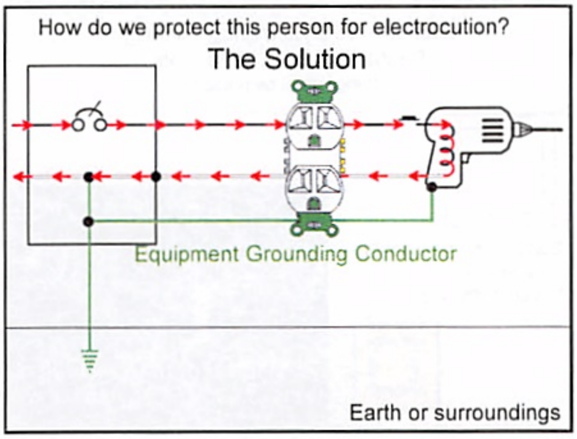
The case of the tool becomes energized?

Case energized
At 120 volts
Earth or surroundings



Professor gets electrocuted!

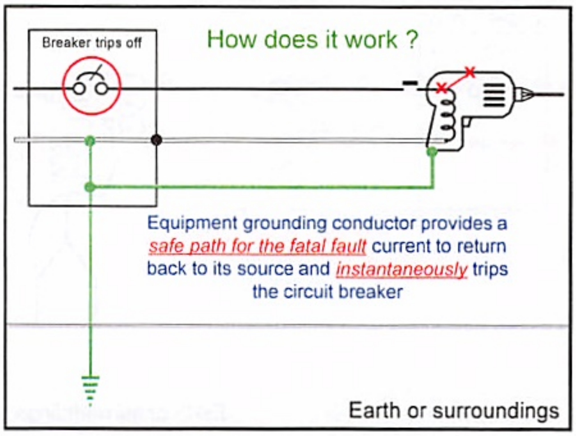
Aaahhh!!
Earth or surroundings



How do we protect this person for electrocution?

The Solution

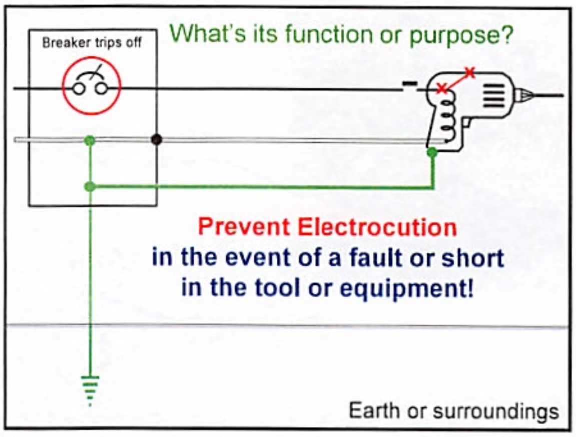
Equipment Grounding Conductor
Earth or surroundings



How does it work ?

Breaker trips off
Earth or surroundings

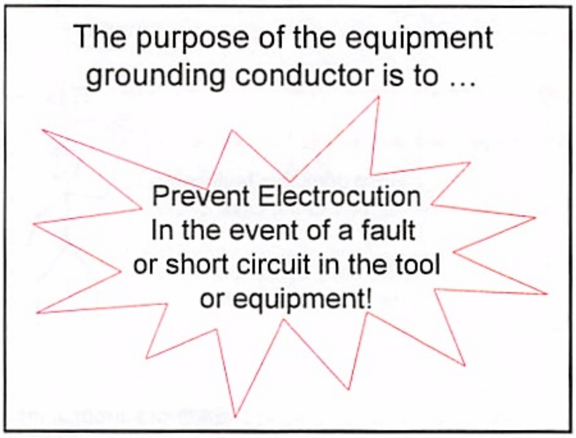
Equipment grounding conductor provides a *safe path for the fatal fault* current to return back to its source and *instantaneously* trips the circuit breaker



What's its function or purpose?

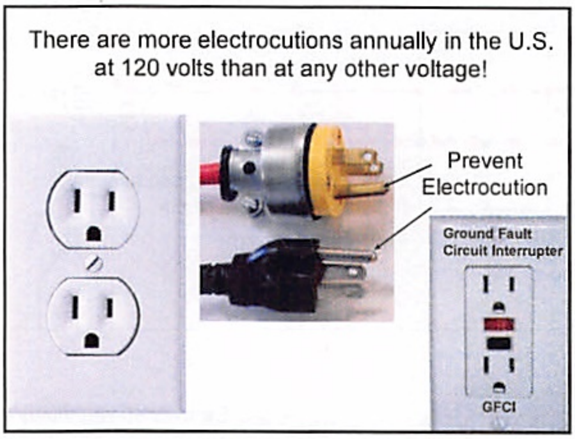
Breaker trips off
Earth or surroundings

Prevent Electrocution
in the event of a fault or short in the tool or equipment!



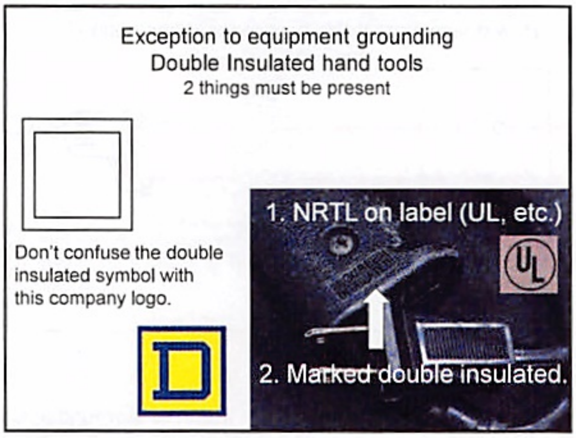
The purpose of the equipment grounding conductor is to …

Prevent Electrocution
In the event of a fault
or short circuit in the tool
or equipment!



There are more electrocutions annually in the U.S. at 120 volts than at any other voltage!

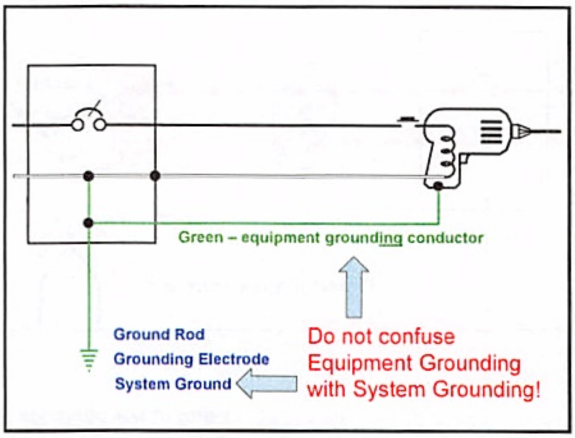
Prevent Electrocution
Ground Fault Circuit Interrupter
GFCI



Exception to equipment grounding
Double Insulated hand tools
2 things must be present

Don't confuse the double insulated symbol with this company logo.

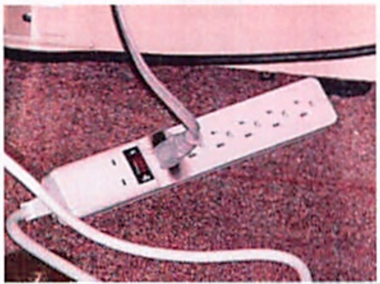
1. NRTL on label (UL, etc.)
2. Marked double insulated.



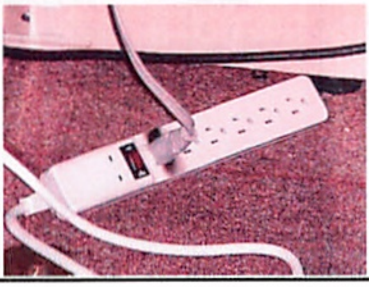
Green – equipment grounding conductor
Ground Rod
Grounding Electrode
System Ground

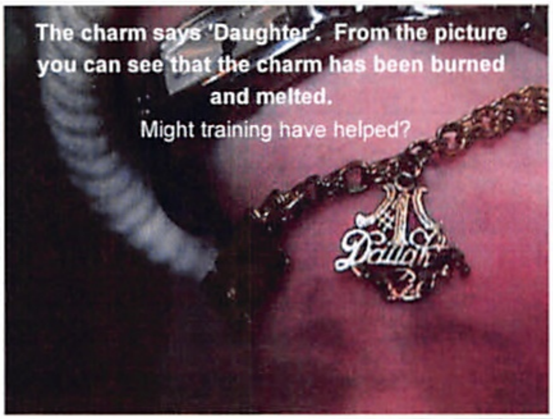
Do not confuse Equipment Grounding with System Grounding!

An office worker was plugging devices into a new (energized) power strip. One plug (shown) was already inserted. The individual was not shocked, but received burns to the wrist.



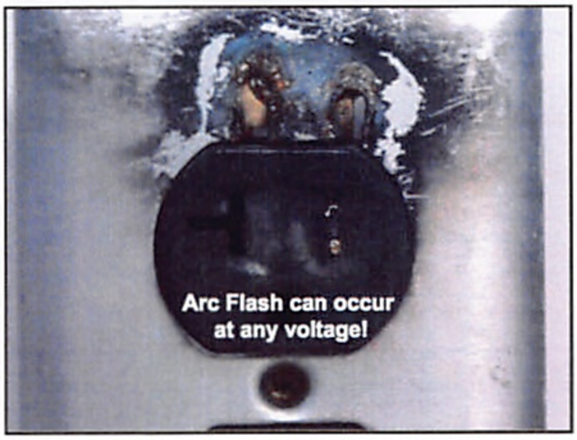
As the second plug was being inserted, a metal charm on a bracelet contacted the hot and ground prongs of the already inserted plug. There was nothing wrong with the devices being utilized or the power strip.





The charm says 'Daughter'. From the picture you can see that the charm has been burned and melted.

Might training have helped?

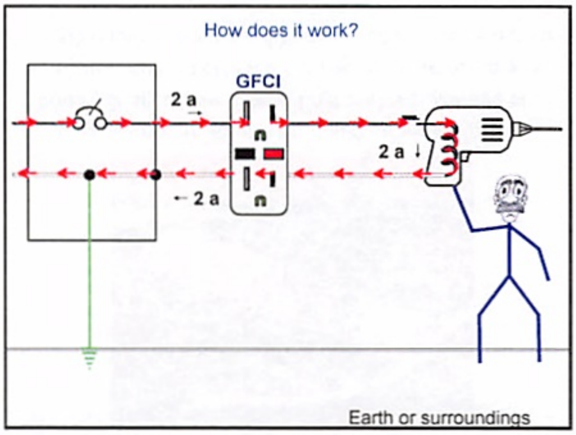


Arc Flash can occur at any voltage!

Conductive Apparel 29 CFR 1910.333(c)(8)
& NFPA 70E 130.8(D)

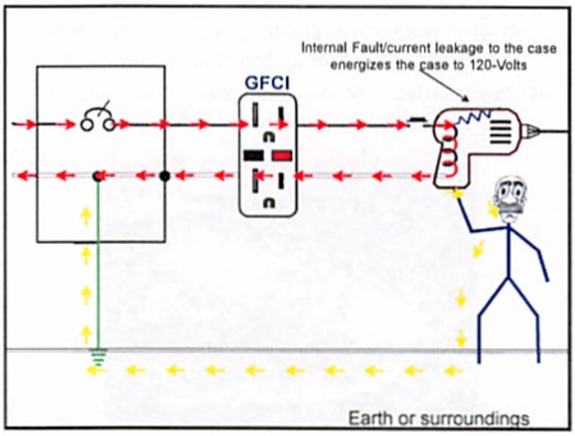
No watches, rings, key chains, necklaces, metal headgear, etc.

Care and maintenance of portable electrical tools and equipment



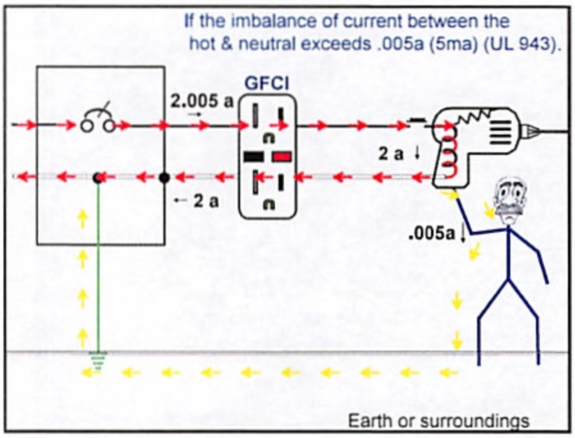
How does it work?

GFCI
2 a
2 a
2 a
Earth or surroundings



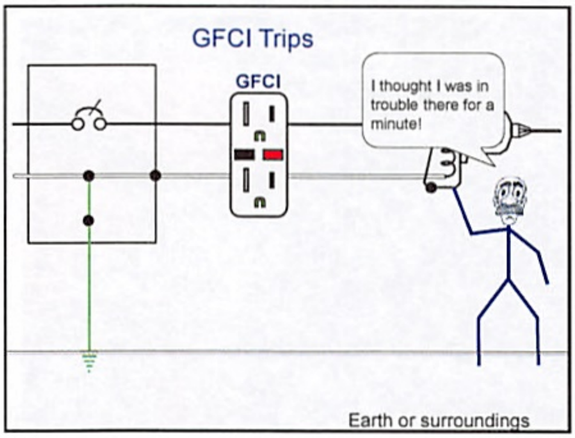
Internal Fault/current leakage to the case energizes the case to 120-Volts

GFCI
Earth or surroundings



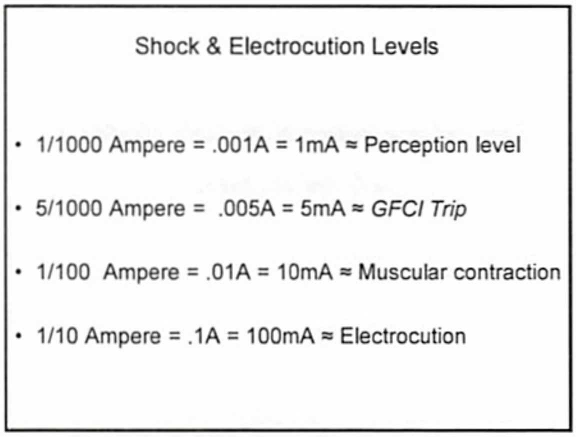
If the imbalance of current between the hot & neutral exceeds .005a (5ma) (UL 943).

GFCI
2.005 a
2 a
2 a
.005a
Earth or surroundings



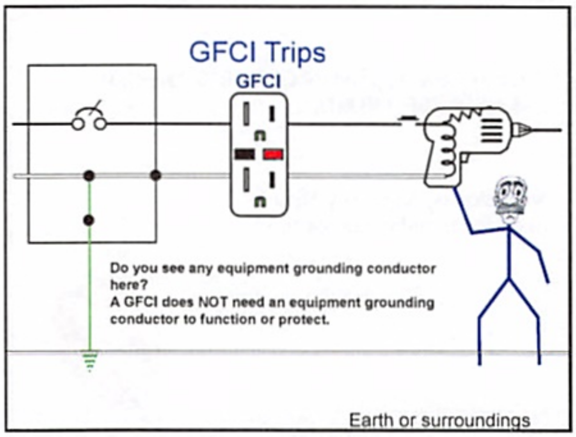
GFCI Trips

GFCI
I thought I was in trouble there for a minute!
Earth or surroundings



Shock & Electrocution Levels

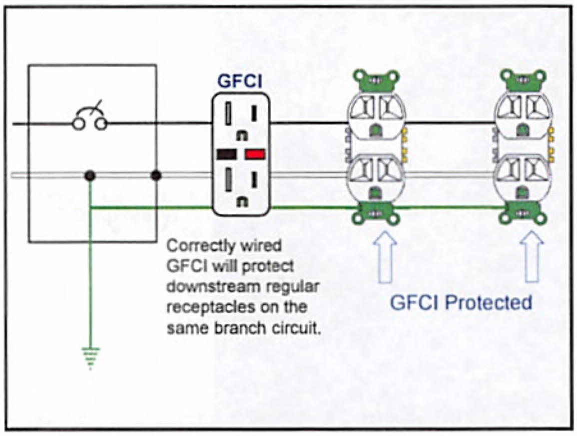
- 1/1000 Ampere = .001A = 1mA ≈ Perception level
- 5/1000 Ampere = .005A = 5mA ≈ *GFCI Trip*
- 1/100 Ampere = .01A = 10mA ≈ Muscular contraction
- 1/10 Ampere = .1A = 100mA ≈ Electrocution



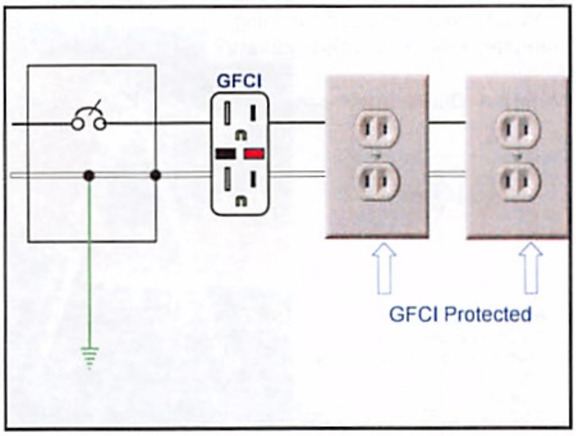
GFCI Trips

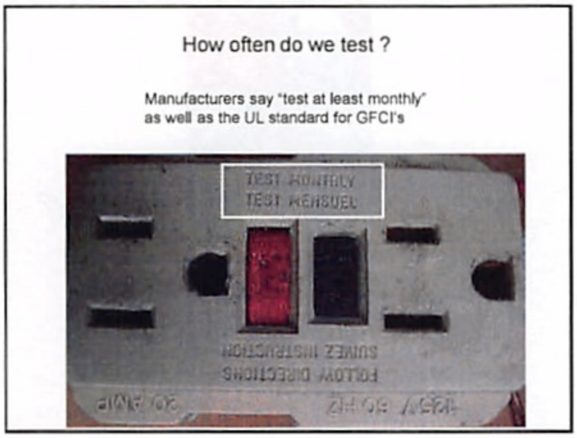
Do you see any equipment grounding conductor here?
A GFCI does NOT need an equipment grounding conductor to function or protect.

GFCI
Earth or surroundings



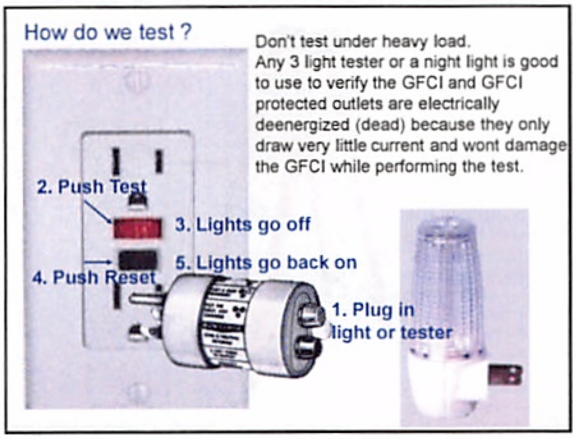
Correctly wired
GFCI will protect
downstream regular
receptacles on the
same branch circuit.





How often do we test ?

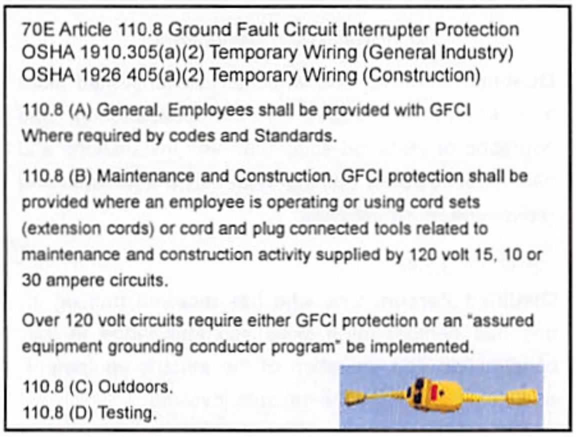
Manufacturers say "test at least monthly"
as well as the UL standard for GFCI's



How do we test ?

Don't test under heavy load.
Any 3 light tester or a night light is good to use to verify the GFCI and GFCI protected outlets are electrically deenergized (dead) because they only draw very little current and wont damage the GFCI while performing the test.

1. Plug in light or tester
2. Push Test
3. Lights go off
4. Push Reset
5. Lights go back on



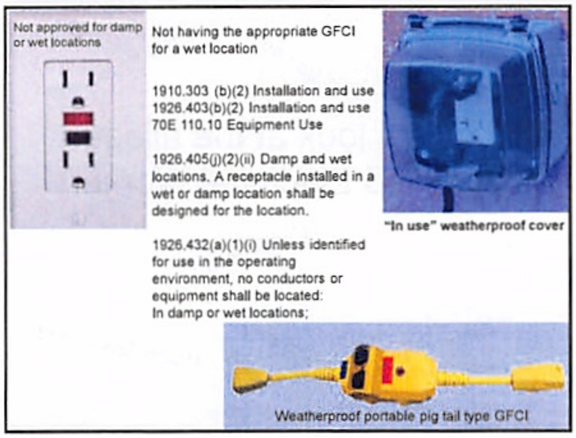
70E Article 110.8 Ground Fault Circuit Interrupter Protection
OSHA 1910.305(a)(2) Temporary Wiring (General Industry)
OSHA 1926 405(a)(2) Temporary Wiring (Construction)

110.8 (A) General. Employees shall be provided with GFCI Where required by codes and Standards.

110.8 (B) Maintenance and Construction. GFCI protection shall be provided where an employee is operating or using cord sets (extension cords) or cord and plug connected tools related to maintenance and construction activity supplied by 120 volt 15, 10 or 30 ampere circuits.

Over 120 volt circuits require either GFCI protection or an "assured equipment grounding conductor program" be implemented.

110.8 (C) Outdoors.
110.8 (D) Testing.



Not approved for damp or wet locations

Not having the appropriate GFCI for a wet location

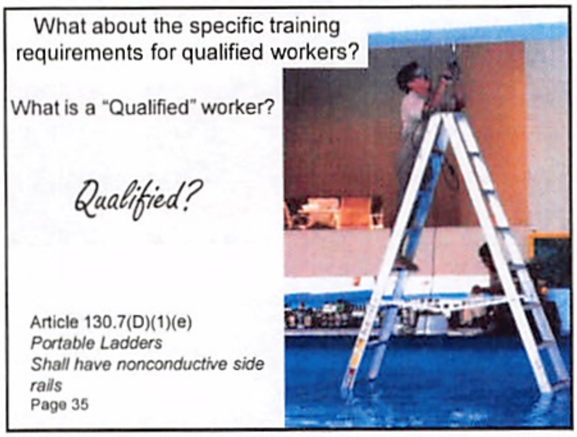
1910.303 (b)(2) Installation and use
1926.403(b)(2) Installation and use
70E 110.10 Equipment Use

1926.405(j)(2)(ii) Damp and wet locations. A receptacle installed in a wet or damp location shall be designed for the location.

1926.432(a)(1)(i) Unless identified for use in the operating environment, no conductors or equipment shall be located:
In damp or wet locations;

"In use" weatherproof cover

Weatherproof portable pig tail type GFCI

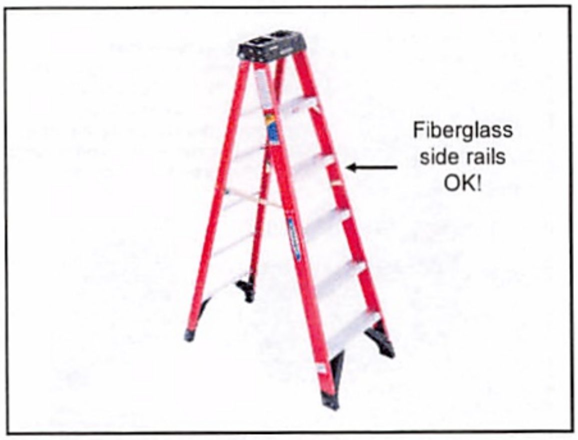

What about the specific training requirements for qualified workers?

What is a "Qualified" worker?

Qualified?

Article 130.7(D)(1)(e)
Portable Ladders
Shall have nonconductive side rails
Page 35

Qualified?


Fiberglass side rails OK!

Fiberglass side rails OK!

Qualified?

Intelligent? Well trained? Highly skilled?

Now lets look at the alleged Qualified Electrical Worker

Insightful? Experienced?

Perceptive? Expert? Highly Qualified?

Δ Article 100 – Definitions

Qualified Person. One who has demonstrated skills and knowledge related to the construction and operation of electrical equipment and installations and has received safety training to identify the hazards and ~~*reduce the associated risk.*~~

OSHA 1910.399

Qualified Person. One who has received training in and has demonstrated skills and knowledge in the construction and operation of the electric equipment and installations and the hazards involved.

OSHA
ESRWP
331-335

OSHA's 1910.333(a) "General." Safety-related work practices shall be employed to prevent electric shock or other injuries resulting from either direct or indirect electrical contacts, when work is performed near or on equipment or circuits which are or may be energized. *The specific safety-related work practices shall be consistent with the nature and extent of the associated electrical hazards.*

Article 110.4(A)(1)
Training – Qualified Person

Δ (A)(1)A qualified person shall be trained and knowledgeable in the construction and operation of equipment or a specific work method and be trained to *identify* and avoid the electrical hazards that might be present with respect to that equipment or work method.

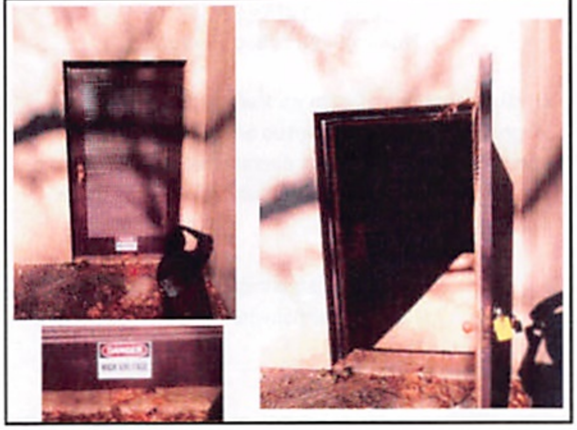
If we really want to know what a "qualified" person begins with, we have to look to the training section

---

Article 110.6(A)(1)(a)
Training – Qualified Person

Such persons shall also be familiar with the proper use of the *special precautionary techniques, applicable electrical policies and procedures, PPE, insulating and shielding materials, and insulated tools and test equipment.*

(b) A person can be considered qualified with respect to certain equipment and methods but still be unqualified for others.



Article 110.4(A)(1)(a)
Training – Qualified Person

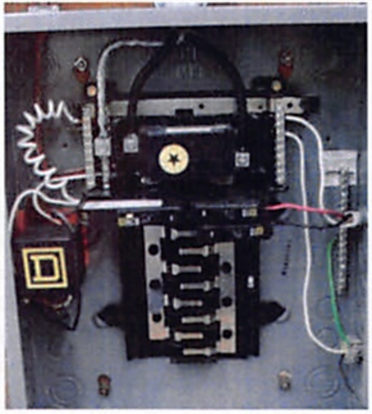
Such persons shall also be familiar with the proper use of the *applicable precautionary techniques, electrical policies and procedures, PPE, insulating and shielding materials, and insulated tools and test equipment.*

(b) A person can be considered qualified with respect to certain equipment and methods but still be unqualified for others.

Article 110.4(A)(1)(c)(1)
Training – Qualified Person

Such persons permitted to work within the *Limited Approach Boundary* of exposed energized electrical conductors and circuit parts operating at 50 volts or more shall, at a minimum, be additionally trained in all of the following: (We'll examine a *Limited Approach Boundary momentarily)*

(1) The skills and techniques necessary to distinguish exposed energized parts from other parts of electrical equipment.



Article 110.4(A)(1)(c)(2)
Training – Qualified Person

Such persons permitted to work within the *Limited Approach Boundary* of exposed energized electrical conductors and circuit parts operating at 50 volts or more shall, at a minimum, be additionally trained in all of the following:

(2) The skills and techniques necessary to determine the nominal voltage of exposed live parts.

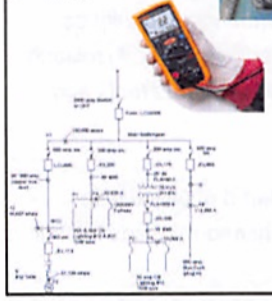
Determine Nominal Voltage…

How do you determine nominal voltage?

Is a multi-meter your first choice?

How do qualified workers determine nominal voltage?

It is important to know the voltage you are working with BEFORE you apply your meter.



Fisher Scientific
69A17C

Article 110.4(A)(1)(c)(3)
Training – Qualified Person

Such persons permitted to work within the *Limited Approach Boundary* of exposed energized electrical conductors and circuit parts operating at 50 volts or more shall, at a minimum, be additionally trained in all of the following:

(3) The approach distances and the corresponding voltages to which the qualified person will be exposed.

This is for electrocution protection

Δ Article 100 – Definitions

Approach boundaries address shock/electrocution hazard.

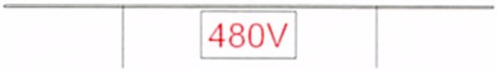
Boundary, Limited Approach. An approach limit at a distance from an exposed energized electrical conductor or circuit part within which a shock hazard exists.

Restricted Approach. An approach limit at a distance from an exposed energized electrical conductor or circuit part within which there is an increased *likelihood* of *electric* shock, due to electrical arc-over combined with inadvertent movement… (considered close proximity)

Sometimes referred to as MAD's in other standards 1910.269

130.4 ~~Shock risk assessment~~ (lets call it a hazard analysis)

130.4(F)(1) No un*qualified person* shall be permitted to approach nearer than the limited approach boundary of energized conductors and circuit parts.



Where does the Limited Approach Boundary begin?

Δ Table 130.4(E)(a) ~~Electric Shock~~ Electrocution Protection Boundaries to Exposed Energized Electrical Conductors or Circuit Parts for Alternating Current Systems

(1)	(2)	(3)	(4)
	Limited Approach Boundary[b]		
Nominal System Voltage Range Phase to Phase[a]	**Exposed Movable Conductor[c]**	**Exposed Fixed Circuit Part**	**Restricted Approach Boundary[b, d]**
Less than 50 V	Not specified	Not specified	Not specified
50 V-150 V[e]	10 ft 0 in	3 ft 6 in	Avoid contact
151 V-750 V	10 ft 0 in	3 ft 6 in	1 ft 0 in
751 V-5 kV	10 ft 0 in	3 ft 6 in	2 ft 1 in
5.1 kV-15 kV	10 ft 0 in	5 ft 0 in	2 ft 2 in

Notes:

(1) For arc flash/arc blast boundary see 130.5(E).

(2) All dimensions are distance from exposed energized electrical conductors or circuit parts to employee.

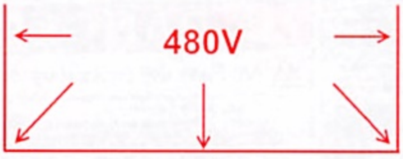
[a] For single phase systems above 250 volts, select the range that is equal to the phase to ground multiplied by 1.732.

[b] See definition in Article 100 and text in 130.4(F)(3) and Annex C for elaboration.

[c] *Exposed movable conductors* describes a condition in which the distance between the conductor and a person is not under the control of the person.

[d] "*Elevation correction factors*".

[e] This includes circuits where the exposure does not exceed 120 volts nominal.



3'6"

A Work Zone must be created

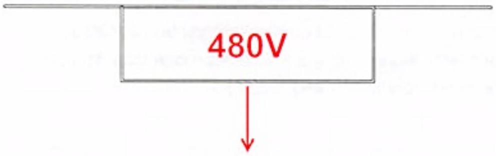
This is for *Electrocution Protection!*

130.4(G) Restricted Approach Boundary. No *qualified person* shall approach or take any conductive object closer to exposed energized electrical conductors or circuit parts operating at 50 volts or more that the restricted approach boundary unless *one* of the following *conditions apply.*

1. The person is insulated - PPE (insulated/voltage rated gloves and/or sleeves, etc. used)
2. The live parts are insulated – (insulated blankets, insulated sheeting, etc.)

130.7(C)(8) Foot Protection – Insulated soles (footwear) shall not be used as primary electrical protection.

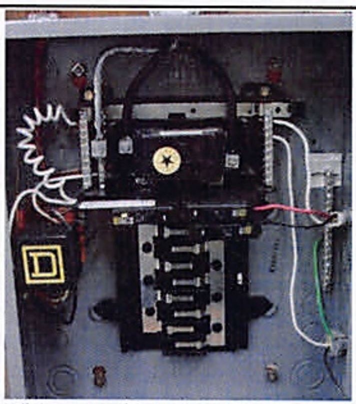
The person is insulated - PPE (insulated/voltage rated gloves and/or sleeves, etc. used)



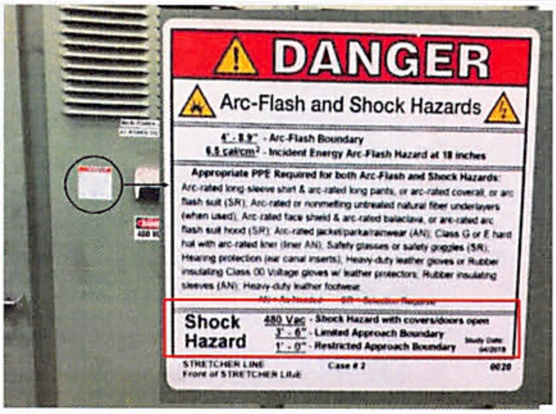
What's the Restricted Approach Boundary in our example?

What must we do at the restricted approach boundary?

At ____, you must protect from the Electrocution Hazard



At what distance would you be required to glove up?



DANGER

Arc-Flash and Shock Hazards

4' - 8.9" - Arc-Flash Boundary
6.5 cal/cm² - Incident Energy Arc-Flash Hazard at 18 inches

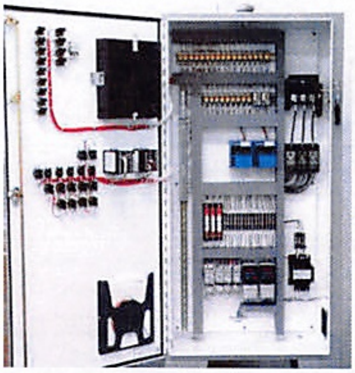
Appropriate PPE Required for both Arc-Flash and Shock Hazards:
Arc-rated long-sleeve shirt & arc-rated long pants, or arc-rated coverall, or arc flash suit (SR); Arc-rated or nonmelting untreated natural fiber underlayers (when used); Arc-rated face shield & arc-rated balaclava, or arc-rated arc flash suit hood (SR); Arc-rated jacket/parka/rainwear (AN); Class G or E hard hat with arc-rated liner (liner AN); Safety glasses or safety goggles (SR); Hearing protection (ear canal inserts); Heavy-duty leather gloves or Rubber insulating Class 00 Voltage gloves w/ leather protectors; Rubber insulating sleeves (AN); Heavy-duty leather footwear

AN = As Needed SR = Selection Required

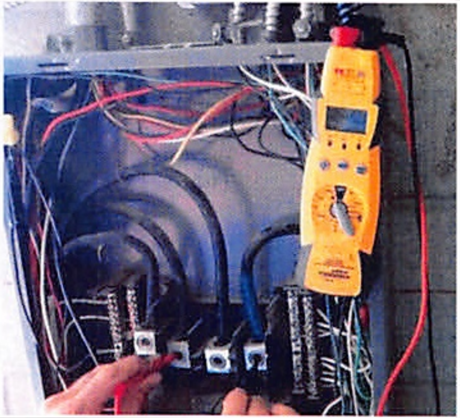
Shock Hazard
480 Vac - Shock Hazard with covers/doors open
3' - 6" - Limited Approach Boundary
1' - 0" - Restricted Approach Boundary
Study Date: 04/2019

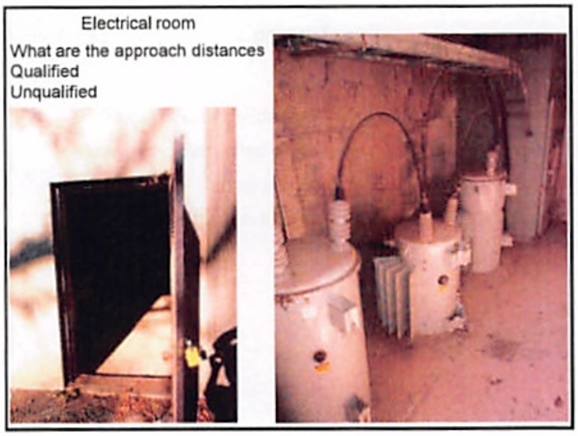
STRETCHER LINE
Front of STRETCHER LINE
Case # 2
0020

The live parts are insulated – (insulated blankets, insulated sheeting, etc.)



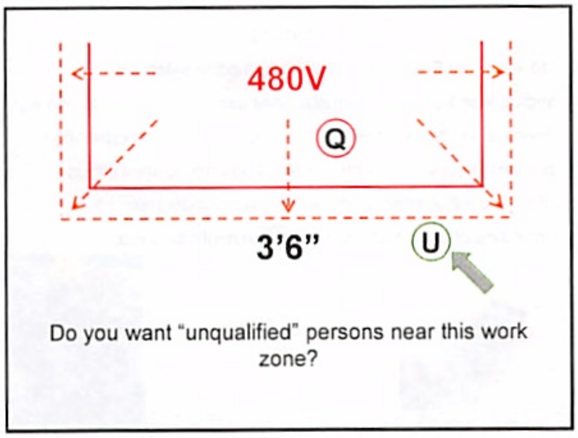
Rubber Insulating Sheeting





Electrical room

What are the approach distances
Qualified
Unqualified



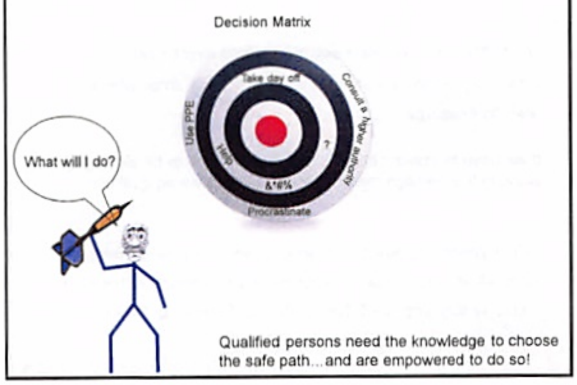
Do you want "unqualified" persons near this work zone?

110.4 Training Requirements.

110.4
Δ(A)(1)(c)(4) Decision Making Process necessary to be able to do the following:

a. Perform the job safety planning
b. Identify electrical hazards
c. Assess the associated ~~risk~~ (hazard)
d. Select the appropriate control methods including PPE

Decision-making process?



Qualified persons need the knowledge to choose the safe path...and are empowered to do so!

Article 130.8(O) – Alerting Techniques (page 40)

(1)(Safety Signs and Tags. Shall be used where necessary – meet requirements of ANSI Z535 standards for safety signs and tags (meet applicable state, federal or local codes & standards)

(2) Barricades. Shall be used in conjunction with signs if necessary...

(3) Attendants. If signs and barricades do not provide sufficient warning and protection an attendant shall be stationed to warn and protect employees. Keep unqualified persons out of the work area/hazards.

What are some unique hazards within your facility that require decision-making?

- Multi-wire branch circuits?
- Delta systems?
- What else?

Training

110.4(A)(1)(e) Employees shall be trained to select an appropriate *test instrument* and shall demonstrate how to use a device to verify the absence of voltage, including interpreting indications provided by the device. The training shall include information that enables the employee to understand all limitations of each *test instrument* that might be used.

Training

110.4A)(1)(f) Employers shall determine through regular supervision or through inspections conducted on at least an annual basis that each employee is complying with the safety-related work practices required by this standard.

130.8 Other Precautions for Personnel Activities

(A)(1) Alertness. Where electrical hazards might exist. Employees shall be instructed to be alert at all times where electrical hazards might exist.

If we have to instruct alleged qualified persons to be alert when working live perhaps they ought not be considered qualified

(A)(2) When Impaired. Employees shall not be permitted to work where electrical hazards exist while their alertness is recognizably impaired due to illness, fatigue, or other reasons.

Article 130.8 – Other Precautions

130.8 Other Precautions for Personnel Activities.

(A)(3) Changes in Scope.
(B) Blind Reaching.
(C) Illumination.

130.8 Other Precautions for Personnel Activities

(D) Conductive Articles Being Worn.

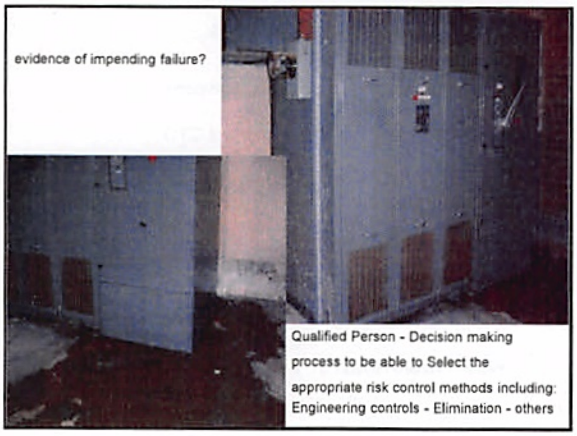
Conductive articles of jewelry and clothing (such as watchbands, bracelets, rings, key chains, necklaces, metalized aprons, cloth with conductive thread, metal headgear, or metal frame glasses) shall not be worn within the restricted approach boundary or where they present an electrical contact hazard with exposed energized electrical conductors or parts.

Article 130.8 – Other Precautions

130.8 Other Precautions for Personnel Activities.

(E) Conductive Materials, Tools, and Equipment Being Handled.
(conductive or fiberglass nonconductive fish tape)
(F) Confined or Enclosed Work Spaces.
(G) Doors or hinges panels. (secure the door from swinging)
(H) Clear Spaces.
(I) Housekeeping Duties.
(J) Occasional Use of Flammable materials.
(K) Anticipating Failure.

evidence of impending failure?



Qualified Person - Decision making process to be able to Select the appropriate risk control methods including: Engineering controls - Elimination - others

Article 130.8 – Other Precautions

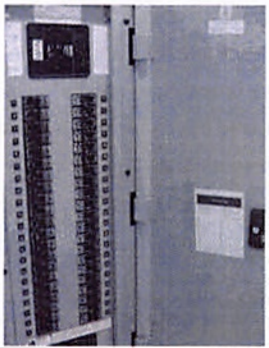
130.8 Other Precautions for Personnel Activities.

(L) Routine Opening and Closing of Circuits.
Load rated switches, circuit breakers, or other devices shall be used.

(M) Reclosing Circuits After Protective Device Operation.
Shall not be manually reenergized until it has been determined that the equipment and circuit can be safely energized (overload versus fault condition).

(N) Safety Interlocks. Control circuit devices can't be used for LOTO purposes.

Change out a breaker. How do we apply engineering controls to engineer out the electrical hazards?



Even if this is a load break rated disconnect, the individual loads on the downstream panel should be "shed", disconnected, opened first.

chickenswitch.com

NFPA 70E, OSHA
and You:
Insight for Implementation
Part 2

Work Conditions

Work is performed in one of TWO conditions:

- Electrically Safe Work Condition. - LOTO
- Unsafe Work Condition. - Energized work

Energized work requires:

- Electrocution Hazard Analysis. ~~Shock risk assessment~~
- Flash Hazard Analysis. ~~Arc flash risk assessment~~

Article 110 General Requirements for Electrical Safety-Related Work Practices

Δ 110.2 Electrically Safe Work Condition.

N (B) When Required. Energized electrical conductors and circuit parts operating at voltages equal to or greater than 50 volts shall be put into an electrically safe work condition before an employee performs work if any of the following conditions exists:

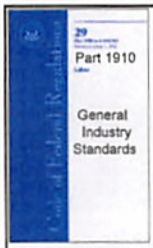
(1) The employee is within the limited approach boundary.
(2) The employee interacts with the equipment where conductors or circuit parts are not exposed but an increased likelihood from exposure to arc-flash exists.

OSHA
ESRWP
.331-.335

1910.333(a)(1) Live parts shall be deenergized before an employee works on or near them...

1910.333(b)(1) If not locked and tagged shall be treated as energized.

1910.333(b)(2) Lockout – Tagout Proceedures...


29
Part 1910
General
Industry
Standards

OSHA has 4 programmatic Lock Out / Tag Out – LOTO Standards in the OSHA Part 1910?

1910.147 LOTO
Control of Hazardous Energy

1910.333 Electrical LOTO

1910.269 (d) LOTO
Generating Plants (very similar to .147)

1910.269 (m & n) for T & D
Includes: Tagging – system operator-
Equipotential Grounding per .269 (n)

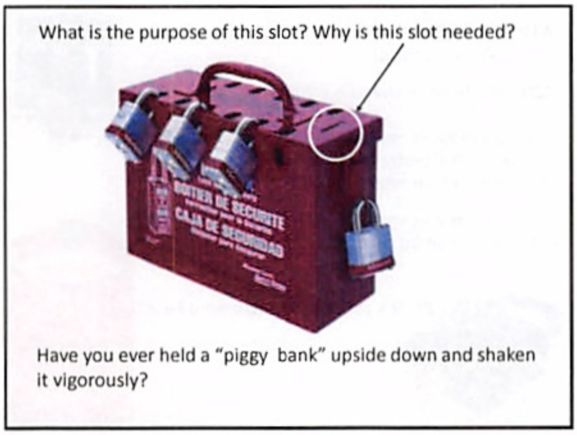
Which standard applies depends on the hazard exposure.

The common element of all the LOTO Standards requires

"Exclusive Control"

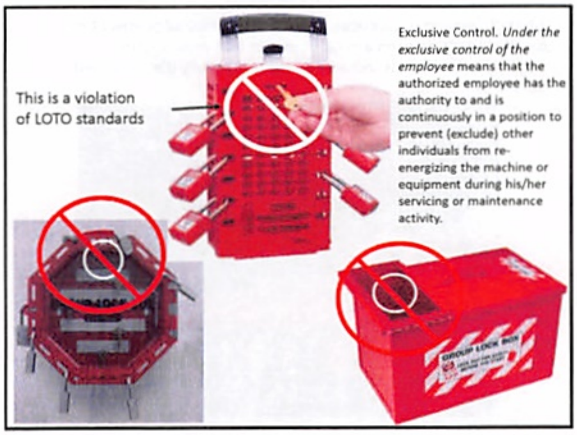
By each and every "Authorized person" / Qualified person performing work under LOTO.

Exclusive Control. *Under the exclusive control of the employee* means that the qualified/authorized employee has the authority to and is continuously in a position to prevent (exclude) other individuals from re-energizing the machine or equipment during hid/her servicing or mainenance activity.



What is the purpose of this slot? Why is this slot needed?

Have you ever held a "piggy bank" upside down and shaken it vigorously?



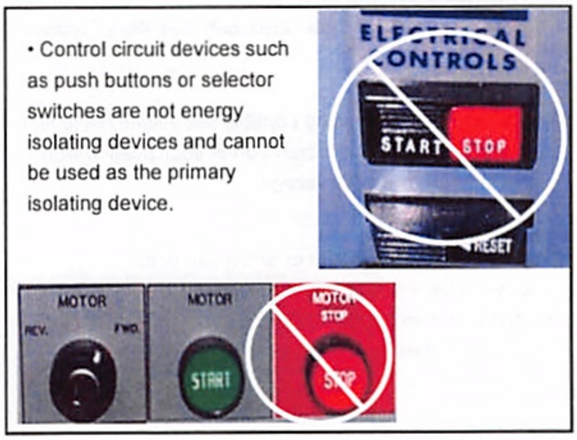
This is a violation of LOTO standards

Exclusive Control. *Under the exclusive control of the employee* means that the authorized employee has the authority to and is continuously in a position to prevent (exclude) other individuals from re-energizing the machine or equipment during his/her servicing or maintenance activity.

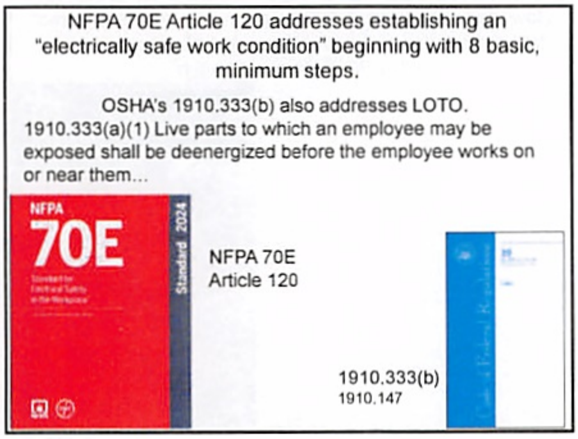
Article 120.2(E) – Control Devices

- Control Devices. Locks/tags shall be installed *only* on circuit disconnecting means. Control devices, such as pushbuttons or selector switches, shall not be used as the primary isolating device.

Control circuit devices are prohibited by all OSHA's LOTO Standards and all other consensus lockout-tagout standards to be used as an "Energy Isolating Device".



- Control circuit devices such as push buttons or selector switches are not energy isolating devices and cannot be used as the primary isolating device.



NFPA 70E Article 120 addresses establishing an "electrically safe work condition" beginning with 8 basic, minimum steps.

OSHA's 1910.333(b) also addresses LOTO. 1910.333(a)(1) Live parts to which an employee may be exposed shall be deenergized before the employee works on or near them...

NFPA 70E
Article 120

1910.333(b)
1910.147

NFPA 70E Article 120 addresses establishing an "electrically safe work condition" beginning with seven basic, minimum steps.

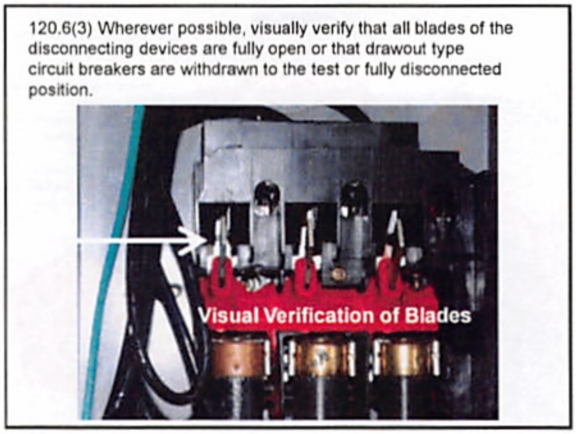
Δ 120.6 Process for Establishing and Verifying an Electrically Safe Work Condition.

(1) Determine all possible sources of electrical supply to the specific equipment. Check applicable up-to-date drawings, diagrams, and identification tags.

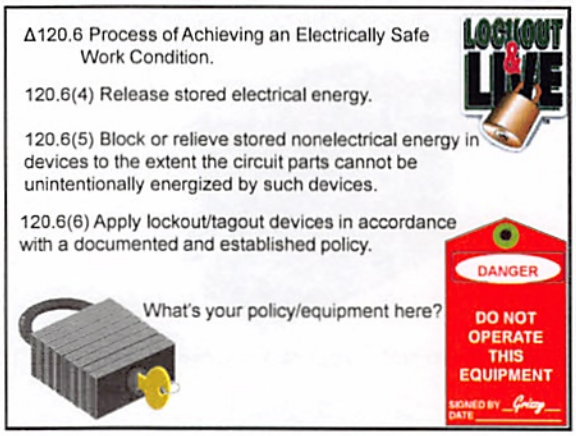
Remember our previous discussion on diagrams and labeling?

(2) After properly interrupting the load current, open the disconnecting device(s) for each source.

Do you use the "Stand Clear" rule?



120.6(3) Wherever possible, visually verify that all blades of the disconnecting devices are fully open or that drawout type circuit breakers are withdrawn to the test or fully disconnected position.



Δ120.6 Process of Achieving an Electrically Safe Work Condition.

120.6(4) Release stored electrical energy.

120.6(5) Block or relieve stored nonelectrical energy in devices to the extent the circuit parts cannot be unintentionally energized by such devices.

120.6(6) Apply lockout/tagout devices in accordance with a documented and established policy.

What's your policy/equipment here?

Δ120.6 Process of Achieving an Electrically Safe Work Condition.

(7) Use an adequately rated portable *test instrument* to test each phase conductor or circuit part at each point of work to test for the *absence of voltage*.

Test each phase conductor or circuit part both phase-to-phase and phase-to-ground. Before and after each test, determine that the *test instrument* is operating satisfactorily *through verification on any known voltage source*.

120.6(7) Use an adequately rated *test instrument* to test each phase conductor or circuit part to test for the *absence of voltage*.

Article 110.6 Test Instruments and Equipment

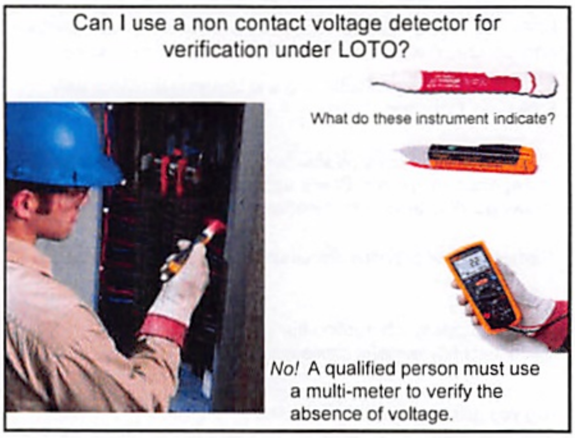
(A) Only qualified persons shall perform tasks with a meter/test equipment.

(B) Rating. Test instruments, equipment, and their accessories shall be rated for circuits and equipment where they are utilized.

(C) Design

(D) Visual Inspection and Repair.

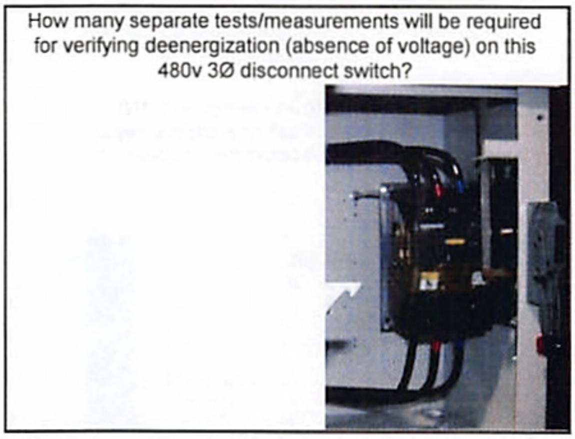
(E) Operation Verification.



Can I use a non contact voltage detector for verification under LOTO?

What do these instrument indicate?

No! A qualified person must use a multi-meter to verify the absence of voltage.



How many separate tests/measurements will be required for verifying deenergization (absence of voltage) on this 480v 3Ø disconnect switch?

120.6 Process of Achieving an Electrically Safe Work Condition.

(8) Where the possibility of induced voltages or stored electrical energy exists, ground all circuit conductors and circuit parts before touching them.
Where it could be reasonably anticipated that the conductors or circuit parts being deenergized could contact other exposed energized conductors or circuit parts, apply temporary protective grounding equipment in accordance with the following.

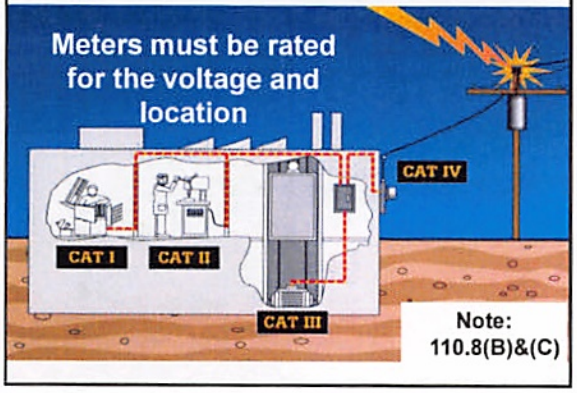
Δ120.6 Process of Achieving an Electrically Safe Work Condition.

120.6 (8)

a. Placement. (ground side connected first and ground side last to be removed)

b. Capacity. (maximum available fault current)

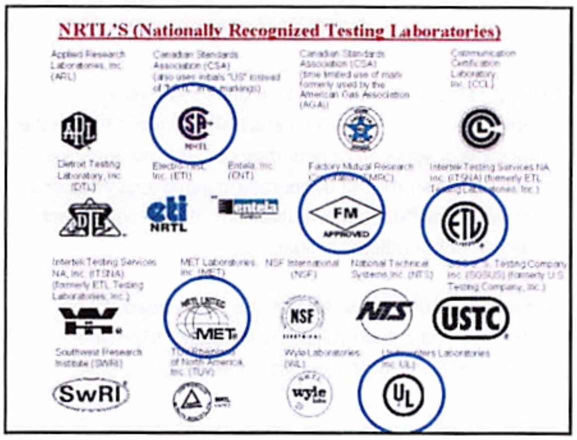
c. Impedance. (low Z for immediate operation of the protective device)



Meters must be rated for the voltage and location

CAT IV
CAT I
CAT II
CAT III

Note: 110.8(B)&(C)



NRTL'S (Nationally Recognized Testing Laboratories)

Applied Research Laboratories, Inc. (ARL)
Canadian Standards Association (CSA) (also uses initials "US" instead of "NRTL" in its markings)
Canadian Standards Association (CSA) (time limited use of mark formerly used by the American Gas Association (AGA))
Communication Certification Laboratory, Inc. (CCL)
Detroit Testing Laboratory, Inc. (DTL)
Electro-Test, Inc. (ETI)
Entela, Inc. (ENT)
Factory Mutual Research Corporation (FMRC)
Intertek Testing Services NA Inc. (ITSNA) (formerly ETL Testing Laboratories, Inc.)
Intertek Testing Services NA, Inc. (ITSNA) (formerly ETL Testing Laboratories, Inc.)
MET Laboratories, Inc. (MET)
NSF International (NSF)
National Technical Systems, Inc. (NTS)
SGS U.S. Testing Company Inc. (SGSUS) (formerly U.S. Testing Company, Inc.)
Southwest Research Institute (SWRI)
TUV Rheinland of North America, Inc. (TUV)
Wyle Laboratories (WL)
Underwriters Laboratories Inc. (UL)

Article 110.6(D) – Visual Inspection and Repair

- Test instruments and equipment and all associated test leads, cables, power cords, probes, and connectors shall be visually inspected for external defects and damage before each use.

If there is a defect or evidence of damage that might expose an employee to injury, the defective or damaged item shall be removed from service. No employee shall use it until a person(s) qualified to perform the repairs and tests that are necessary to render the equipment safe has done so.

OSHA Electrical LOTO
1910.333(b)

Deenergize - LOTO

1910.333 (b)(1) Not locked & tagged - Treat as energized
(b)(2) Lockout & Tagging

(i) Procedures written (copy of this paragraph meets requirements)
(ii) Deenergize Equipment - release stored energy
(iii) Application of Locks & Tags (Locks & tags required unless requirements of .333(b)(2)(iii)(E) is met.
(iv) Verification of deenergization & Test equipment
(v) Reenergization

Be sure to follow your specific LOTO program requirements and procedures!

Now the narrow exceptions to LOTO

*N*110.3(B)When Required. Energized electrical conductors and circuit parts operating at voltages equal to or greater than 50 volts shall be put into an electrically safe work condition before an employee performs work if *any* of the following conditions exist:

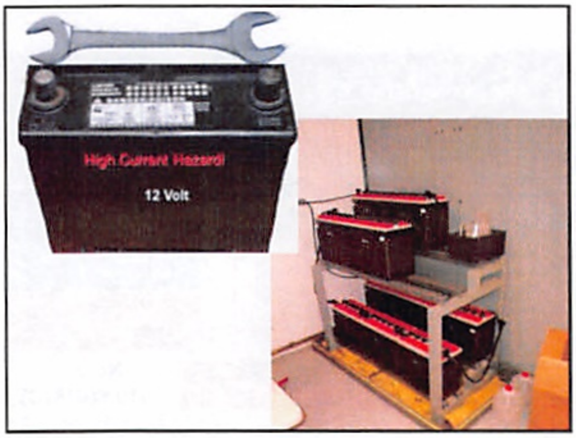
(1) The employee is within the limited approach boundary

(2) The employee interacts with equipment where conductors or circuit parts are not exposed, but an increased risk of injury from an exposure to arc flash hazard exists.

OSHA 333(a)(1)

333(a)(1) Deenergized Parts. Live parts to which an employee may be exposed shall be deergized before the employee works on or near them, unless the employer can demonstrate that deenergizing introduces additional or increased hazards or is infeasible due to equipment design or operational limitations.

Live parts that operate at less than 50 volts need not be deenergized if there will be no increased exposure to electrical burns or to explosion due to electric arcs.

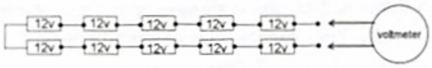


130.2(A) Energized Work. (narrow exceptions to LOTO)

(1) Greater Hazard. Energized work shall be permitted where the employer can demonstrate that de-energizing introduces additional or greater hazards or increased risk.

(2) Infeasibility. Energized work shall be permitted where the employer can demonstrate that the task to be performed is infeasible in a de-energized state due to equipment design or operational limitations.

arc blast/arc flash



A retired Navy Chief burned his finger the other day. He was an aircraft electrician for 20+ years and had all the same safety training we do. He was removing a battery cable on a boat. The battery was a large 12V deep cycle and he was using an un-insulated crescent wrench.

The wrench slipped in his hand and touched his wedding ring and both battery terminals at the same time. As soon as he saw the spark, he dropped the wrench and pulled off his ring as fast as he could.

The wrench landed on top of the battery and melted some of the plastic.

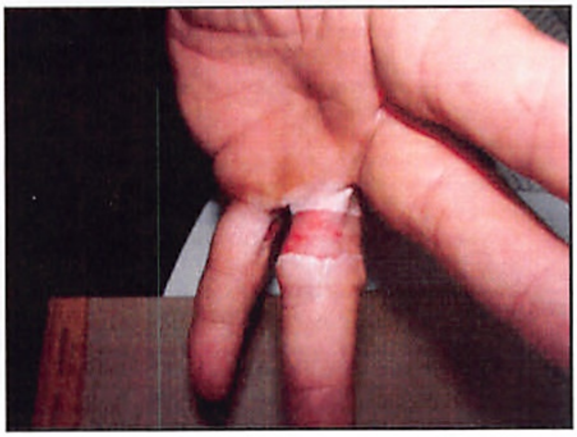
The ring was so hot, it started boiling the water on the deck when he dropped it.

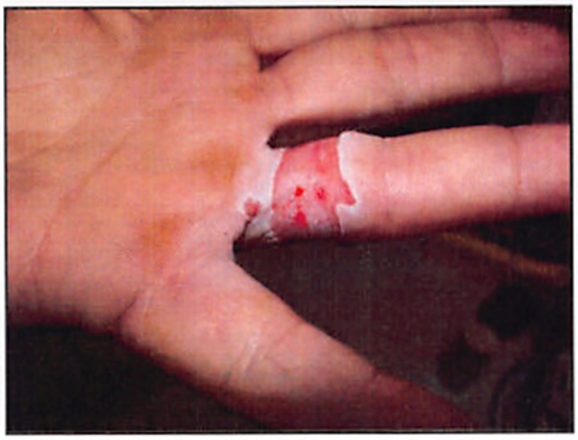
You can see parts of the wrench fused onto the ring and gaps in the ring that are now part of the wrench.

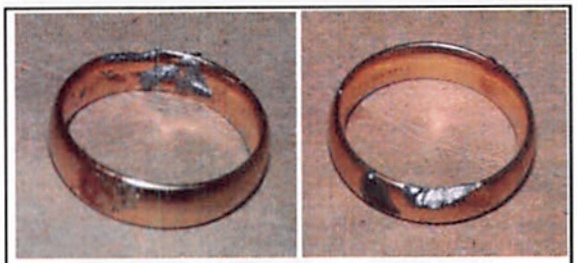
The doctor later told him if he'd had the ring on for a few seconds longer, he would have permanently lost feeling in his finger.

His finger didn't start hurting for a little more than a week after he burned it.

This happened from 12 volts (DC) in less than 2 seconds.







Conductive Apparel
1910.333(c)(8) & 70E 130.8(D)

No watches, rings, key chains, necklaces, metal headgear, etc.

1910.333(a)(1) Live parts to which an employee may be exposed shall be deenergized before the employee works on or near them, unless the employer can demonstrate....
Greater Hazard or Infeasibility

(Narrow Exceptions to LOTO)

(1) Greater Hazard. Energized work shall be permitted where the employer can demonstrate that de-energizing introduces additional or greater hazards or increased risk.

(2) Infeasibility. Energized work shall be permitted where the employer can demonstrate that the task to be performed is infeasible in a de-energized state due to equipment design or operational limitations.

Greater Hazard

Hazardous / Classified location declassified through appropriate ventilation

Working on ventilation equipment which is used to declassify hazardous / classified locations

Infeasibility

Not inconvenience

Diagnostics / troubleshooting

Infeasible due to operational limitations, such as.... performing diagnostics and testing of electric circuits that can only be performed with the circuit energized.

1910.333(a)(1) Live parts to which an employee may be exposed shall be deenergized before the employee works on or near them, unless the employer can demonstrate.... Greater Hazard or Infeasibility

(Narrow Exceptions to LOTO)

(1) Greater Hazard. Energized work shall be permitted where the employer can demonstrate that de-energizing introduces additional or greater hazards or increased risk.

(2) Infeasibility. Energized work shall be permitted where the employer can demonstrate that the task to be performed is infeasible in a de-energized state due to equipment design or operational limitations.

Lets look at the feasibility/infesibility of deenergizing Critical Life Support Systems

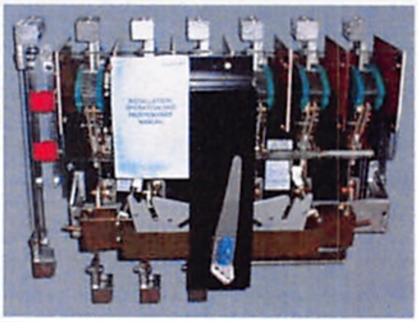
We have to work live because we can't

Interrupt Critical Life Support Systems

(ie: ER, ICU, etc.)

Company adopts 'No Energized Work' Policy

A shop was contracted by a hospital to add an in-phase monitor to an existing transfer switch



The transfer switch provided emergency power to the operating rooms, and we were asked to wire in the monitor with the transfer switch energized.

A Senior Technician was sent to do the installation, who had recently been to training at ASCO.

When the technician arrived, he prepared his work area by *laying down a rubber mat* and was seated on a small stool.

He did not bring a *flash suit or high voltage gloves*, although that PPE was available to him back at the shop.

The accident happened about an hour after the technician began the work.

It appears that a ***loose wire*** hit the **480V bus** or a **screwdriver** slipped causing the arc blast.

There were two or three rapid blasts knocking the technician off his stool to the floor.

The technician was hospitalized for three weeks with burns on his hand, forearms, and face.

The hospital experienced a *power outage* in the *operating rooms and intensive care units.*

The transfer switch was completely destroyed.

An electrical contractor restored power in about **four hours**.

We now have a policy of *no energized work.*

We have implemented this policy and thus far have not lost one job or had one customer complaint.

Recent Inquiry

Electrical maintenance work at a hospital.

This contractor understands that the vast majority of time all work can be and should be locked out and tagged out, but these hospitals are unique in many ways. There are some critical systems that the contractor questions when they can do live work and not shut down the unit substation.

If live work is allowed can you write a report as an expert and state the reasons / circumstances that live work is allowed and provide references by the 29 CFR 1926, 29 CFR 1910, Directive, CPL's, Interpretations, NEC, NFPA, and any other publishing organization

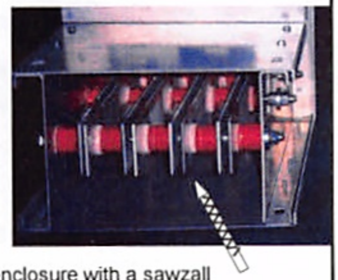
Recent Inquiry

The electrical substation (4,160 volts and stepped down to 480 volts)

"We are dealing with some very high energy gear (substation) here and if something goes awry, not only are the workers working on the equipment likely to be killed, the outages are likely to kill a patient.
Substation feeds: ER, ICU, OR 1-9, recovery, CCU, emergency power outlets, dialysis, nurses call stations, fire alarm system, exit lights, etc.
Additionally, I'm not even sure at this point they can meet the exemption requirements of the standards for actually doing the work energized."

CSHO e-mail to Grizzy regarding an accident investigation and request for recommended investigative approach.

A licensed electrician was **cutting into** a metal collector box itself suspended from the ceiling, containing an energized 480 volt 3,000 amp three phase bus in an electrical vault.



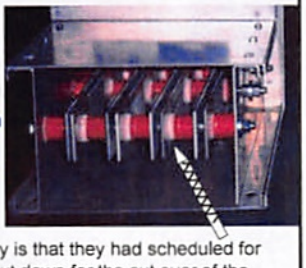
Sawing into the enclosure with a sawzall

What do you supposed occurred?

Metal remnants after the arc blast.

A licensed electrician was **cutting into** a metal collector box itself suspended from the ceiling, containing an energized 480 volt 3,000 amp three phase bus in an electrical vault.

How can I prove that the metal conductive tool such as a jig saw made contact with the live bus, when **the person using the tool denies that he contacted the energized bus.**



What makes this case so crazy is that they had scheduled for the following day an 8 hour shut down for the cut over of the new bus bars feeding into the collector box. The electrician wanted to "get a jump on the job".

The Employers affirmative defense:

- this was a coincidental failure
- of that equipment
- at that specific location
- at that exact point in time
- just when my employee was working there

.333(a)(1) Live parts shall be deenergized before working or them, unless the employer can demonstrate greater hazard or infeasibility.

Article 110.3 Energized parts shall be put into an electrically safe work condition before an employee performs work.

Because # · @ % just happens !!!

Remember, OSHA directs & conducts the investigation!

What's the reason for working energized?

Is it really *infeasible*?
Or was it just *inconvenient?*

O'Hare case

Infeasible or Inconvenient?

O'Hare Airport

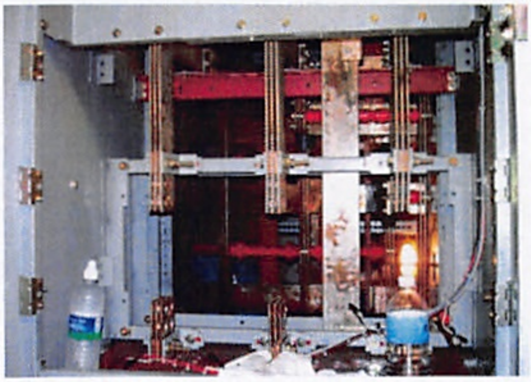
New 480 volt switchgear for entire terminal

Utility fed at 480 with 35,000 amps fault current

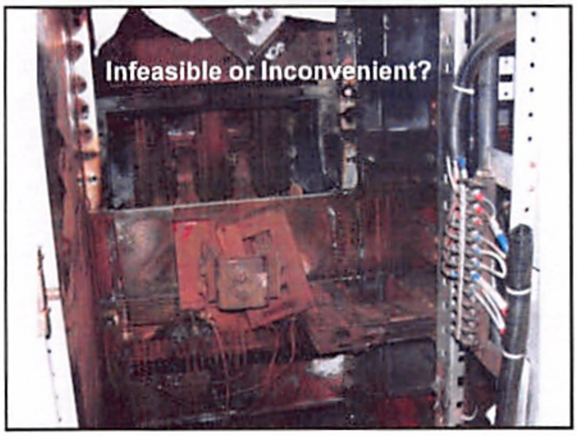
Manufacturer adding bus tap for CT energized

Cost to deenergize after hours $ 60,000.

We can't shut down an airport!

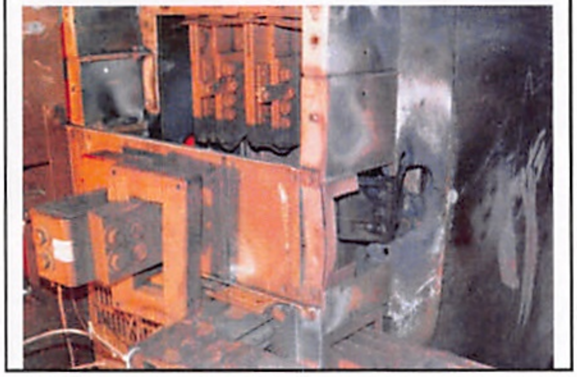


Infeasible or Inconvenient?



Infeasible or Inconvenient?

Infeasible or Inconvenient?



Infeasible or Inconvenient?

$ 1,000,000 gear destroyed

2 injured workers $$$

One worker with 2nd & 3rd degree burns $$$$

Entire airport terminal shut down $$$$$$$$$$$

Airline computer system crashed $$$$$$$$$$$

All building business occupants totally shut down

DANGER
HAZARD OF SERIOUS OR FATAL ELECTRICAL SHOCK OR BURN
TURN OFF POWER AT UTILITY
BEFORE WORKING BEHIND THIS COVER
THE LINE SIDE BUS OF ANY MAIN BREAKER OR SWITCH REMAINS ENERGIZED WHEN THE MAIN IS IN THE OFF POSITION

1910.303(b)(2), 1926.403(b)(2) Installation and Use.

NFPA70E Article 130.2 Electrically safe work condition. Live parts shall be put into an electrically safe work condition before work is performed…

You might not have the authority to shut down your facility or the site!

However, if you: Supervise, assign, work on, have oversight or any responsibility for, or do electrical work…

You have the power to shut down the entire facility or site!

If you think a planned outage is a pain in the * # # ?

You should try one of these unplanned events and see what a pain in the * # # that is!

Can you afford to work it Energized?

Can you afford to do the job energized?

Average burn case costs between
$12,000,000 to $20,000,000
in medical expenses & lost time

Average hospital burn unit stay costs
$400,000 / month

Average hospital burn unit stay
is 3 months

N110.2(B) When Required

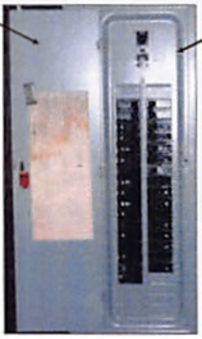
Exception No. 1: Normal operation of electrical equipment shall be permitted where a normal operating condition exists. A normal operating condition exists when all of the following conditions are satisfied.

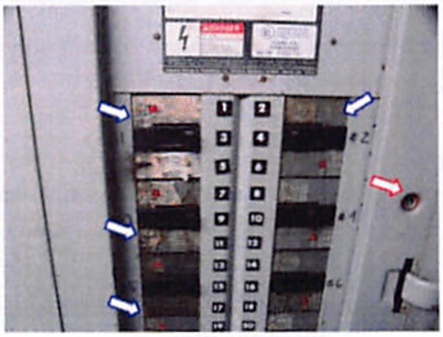
1. *The equipment is properly installed.*
2. *The equipment is properly maintained.*
3. *The equipment is rated for the available fault current.*
4. *The equipment is used in accordance with instructions included in the listing and labeling and in accordance with mfg. instructio*
5. *The equipment doors are closed and secured.*
6. *All equipment covers are in place and secured.*
7. *There is no evidence of impending failure.*

The equipment doors are closed and secured is not referring to this door, because the "dead front" cover is in place and secured.

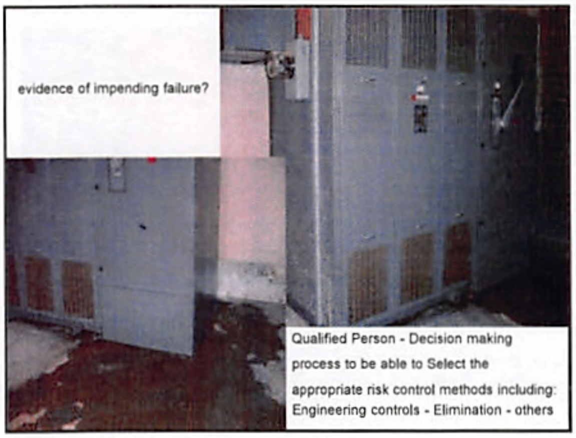
All dead front cover screws in place

Dead front cover





The equipment is properly installed?
All equipment covers are in place and secured?



evidence of impending failure?

Qualified Person - Decision making process to be able to Select the appropriate risk control methods including: Engineering controls - Elimination - others

Article 130.2 Energized Electrical Work Permit

130.2(A)(1) When energized work is permitted in accordance with 110.4 an energized electrical work permit shall be required and documented under the following conditions:

(1) When work is performed within the restricted approach boundary.
(2) When the employee interacts with the equipment when conductors and circuit parts are not exposed but an increased likelihood of injury from an exposure to arc flash hazard exists.

Article 130.2(B) – EEWP
Annex J

Description of the circuit/equipment/job location.

Description of the work to be done.

Justification of why the work cannot be deenergized or the work deferred to the next scheduled outage.

Detailed description of the job procedures to be used.

Description of safe work practices to be employed.

Results of the ~~electric shock~~ electrocution ~~risk assessment~~ hazard analysis. (voltage, boundaries, PPE to be used).

Results of the arc flash hazard analysis. (available incident energy of arc flash PPE category, necessary arc flash PPE, arc flash boundary).

Article Δ 130.2(B) – EEWP
Annex J

Means employed to restrict access of unqualified persons

Evidence of completion of job briefing including discussion of hazards.

Energized work approval – signatures required (qualified persons, manufacturing manager, safety manager, general manager).

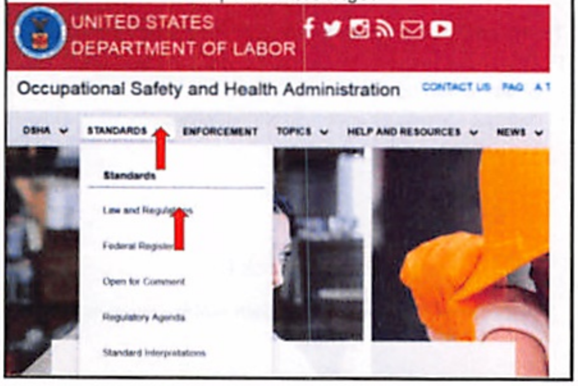
130.2(C) Exemptions to Work Permit.

Electrical work permit shall be permitted without an electrical work permit if a qualified person is provided with and uses appropriate safe work practices and PPE in accordance with chapter 1 under any of the following conditions:

(1) Testing, troubleshooting, and voltage measuring
(2) Thermography and visual inspections if the restricted approach boundary is not crossed
(3) Access to and egress from an area with energized electrical equipment if no electrical work is performed and the restricted approach boundary is not crossed
(4) General housekeeping and miscellaneous non-electrical tasks if the restricted approach boundary is not crossed.

You must still perform all other elements of the EEWP

Electrical PPE
https://www.osha.gov



Part Number: 1910
Part Number Title: Occupational Safety and Health Standards
Subpart: 1910 Subpart I
Subpart Title: Personal Protective Equipment
Standard Number: **1910.137**
Title: Electrical Protective Equipment.

1910.137(a) *Design requirements for specific types of electrical protective equipment.* Rubber insulating blankets, rubber insulating matting, rubber insulating covers, rubber insulating line hose, rubber insulating gloves, and rubber insulating sleeves shall meet the following requirements:
1910.137(a)(1) *Manufacture and marking of rubber insulating equipment.*
Etc.

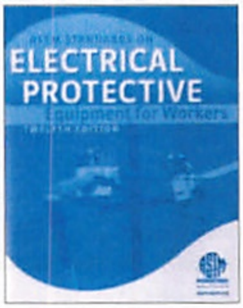
1910.137(b)
Design requirements for other types of electrical protective equipment.
Etc.

1910.137(c)
In-service care and use of electrical protective equipment. (periodic proof test, including daily inflation test, and daily inspection, etc.).

Shock hazard analysis – PPE – approach boundaries

ASTM standards for Electrical PPE

Referenced in 70E
Table 130.7(C)(14)



F 18 Committee

D120-02 Standard Specification for Rubber Insulating Gloves

D178-01(2005) Standard Specification for Rubber Insulating Matting

D1048-05 Standard Specification for Rubber Insulating Blankets

D1049-98(2002) Standard Specification for Rubber Insulating Covers

D1050-05 Standard Specification for Rubber Insulating Line Hose

D1051-02 Standard Specification for Rubber Insulating Sleeves

F478-92(1999) Standard Specification for In-Service Care of Insulating Line Hose and Covers

F479-95(2001) Standard Specification for In-Service Care of Insulating Blankets

F496-02 Standard Specification for In-Service Care of Insulating Gloves and Sleeves

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F696-02 Standard Specification for Leather Protectors for Rubber Insulating Gloves and Mittens

F711-02 Standard Specification for Fiberglass-Reinforced Plastic (FRP) Rod and Tube Used in Live Line Tools

F712-88(2000) Standard Test Methods for Electrically Insulating Plastic Guard Equipment

F819-05 Standard Terminology Relating to Electrical Protective Equipment for Workers

F855-04 Standard Specifications for Temporary Protective Grounds to Be Used on De-energized Electric Power Lines and Equipment

F887-05 Standard Specifications for Personal Climbing Equipment

F914-03 Standard Test Method for Acoustic Emission for Insulated and Non-Insulated Aerial Personnel Devices Without Supplemental Load Handling Attachments

F968-93(2002) Standard Specification for Electrically Insulating Plastic Guard Equipment for Protection of Workers

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F1116-03 Standard Test Method for Determining Dielectric Strength of Dielectric Footwear

F1117-03 Standard Specification for Dielectric Footwear

F1236-96(2001) Standard Guide for Visual Inspection of Electrical Protective Rubber Products

F1430-03 Standard Test Method for Acoustic Emission Testing of Insulated and Non-Insulated Aerial Personnel Devices with Supplemental Load Handling Attachments

F1505-01 Standard Specification for Insulated and Insulating Hand Tools

F1506-02 Standard Performance Specification for Flame Resistant Textile Materials for Wearing Apparel for Use by Electrical Workers Exposed to Momentary Electric Arc and Related Thermal Hazards

F1564-95(2000) Standard Specification for Structure-Mounted Insulating Work Platforms for Electrical Workers

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ASTM Electrical Protective Equipment for Workers

Equipment	Mfg.Standard Specification	In Service Care
Gloves	D 120	F 496
Sleeves	D 1051	F 496
Blankets	D 1048	F 479
Line Hose	D 1050	F 478
Insulating Covers	D 1049	F 478
Matting	D 178	none
Plastic guard	F 968	none

See Table 130.7(C)(14) Standards on Protective equipment (page 34)

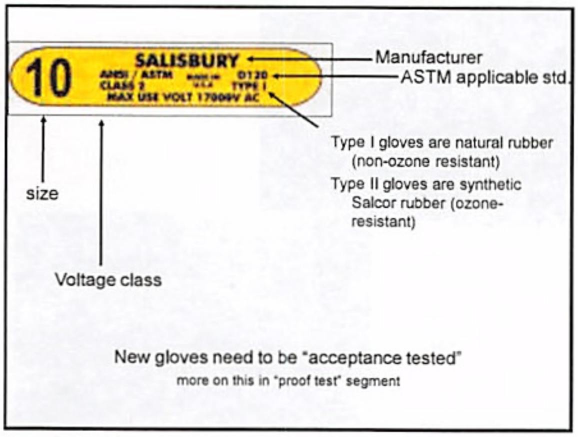
Care and Use

Thoroughly inspect Gloves and Leathers at start of shift*
PLUS, Quick inspection each time you put them on.

- Gloves should be clean
- Inspection should be done with strong lighting

"What do I look for?"

*Re-inspect if there is any possibility that the gloves could have become damaged


10
SALISBURY
ANSI / ASTM
MADE IN U.S.A.
D120
CLASS 2
TYPE I
MAX USE VOLT 17000V AC

Manufacturer

ASTM applicable std.

Type I gloves are natural rubber (non-ozone resistant)

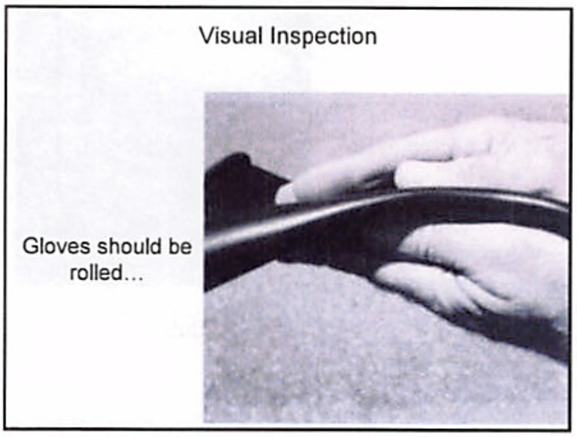
Type II gloves are synthetic Salcor rubber (ozone-resistant)

size

Voltage class

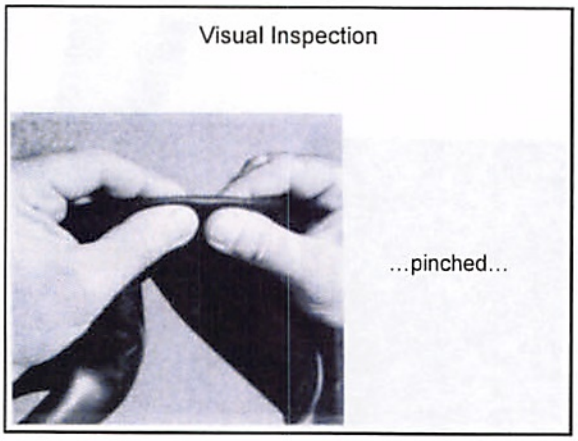
New gloves need to be "acceptance tested"

more on this in "proof test" segment



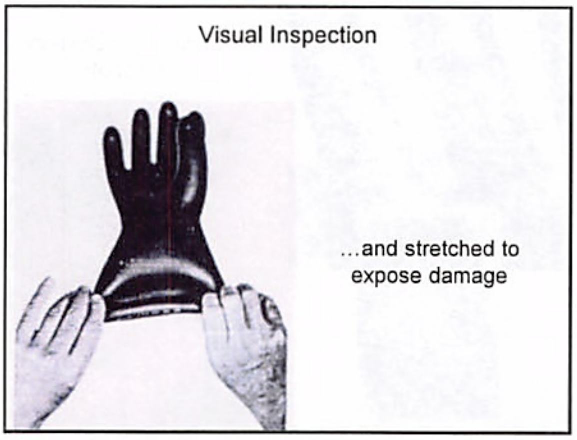
Visual Inspection

Gloves should be rolled…



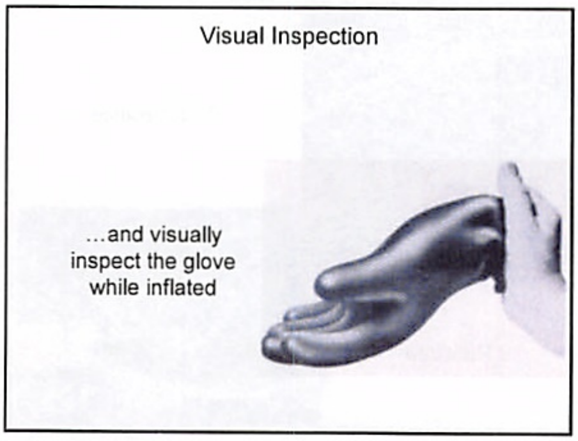
Visual Inspection

…pinched…



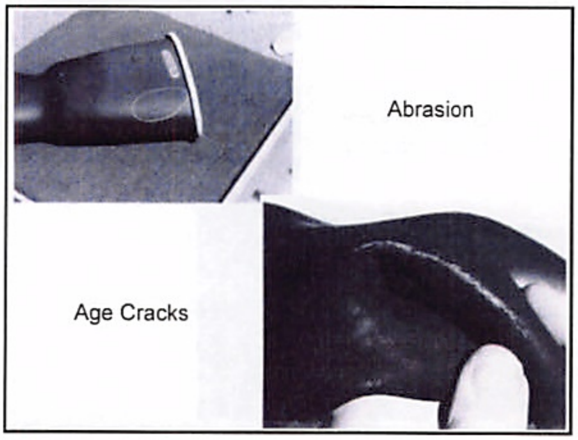
Visual Inspection

…and stretched to expose damage



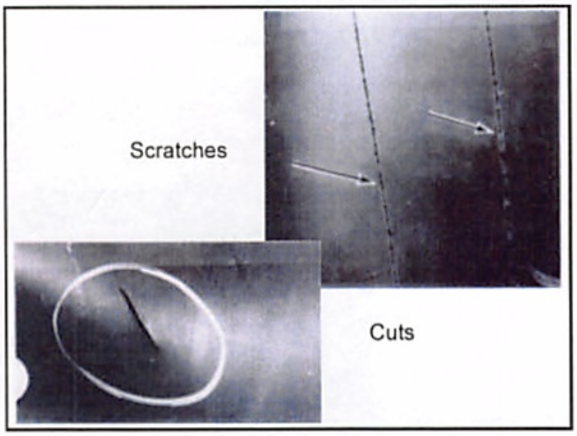
Visual Inspection

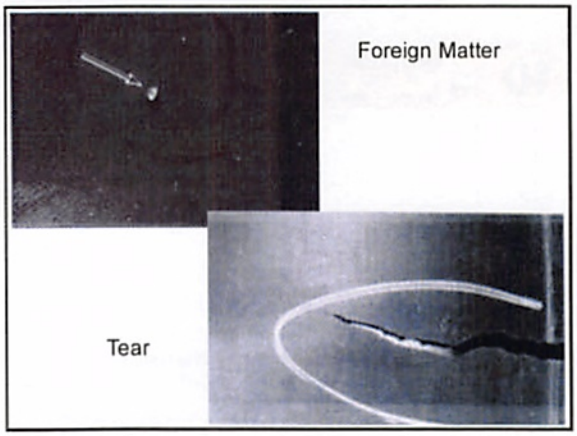
…and visually inspect the glove while inflated

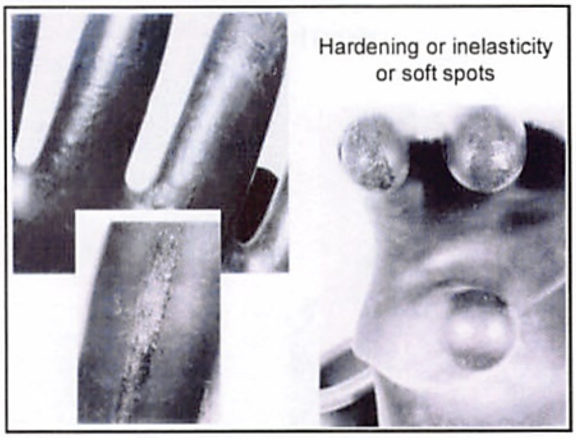


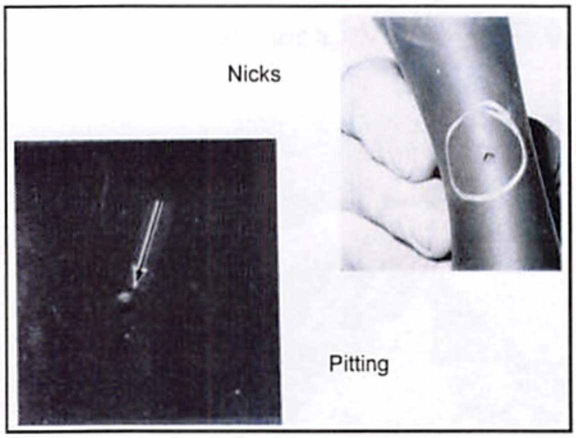
Abrasion

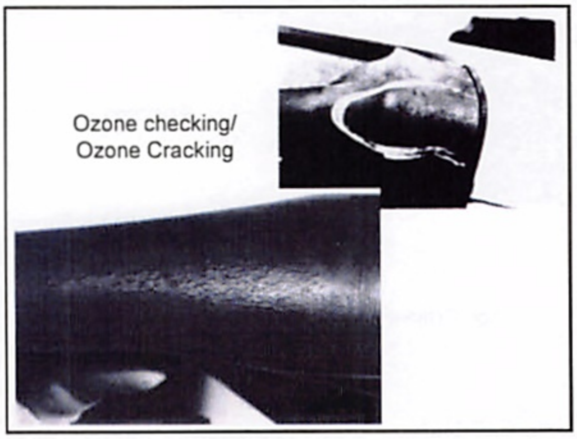
Age Cracks

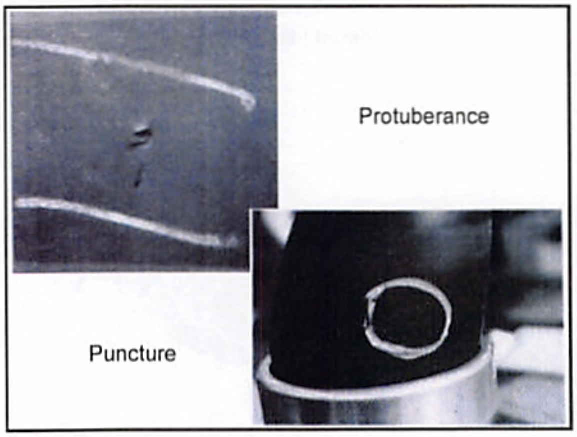

Scratches
Cuts


Foreign Matter
Tear


Hardening or inelasticity or soft spots


Nicks
Pitting


Ozone checking/
Ozone Cracking


Protuberance
Puncture

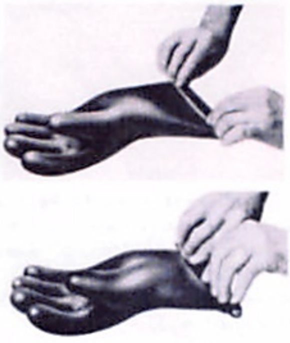
REJECT!

Gloves or sleeves found upon inspection to have cuts, snags, cracks, burns, ozone cutting/checking, swelling, abrasions, contamination from injurious materials, or that have lost normal elasticity, shall be rejected.

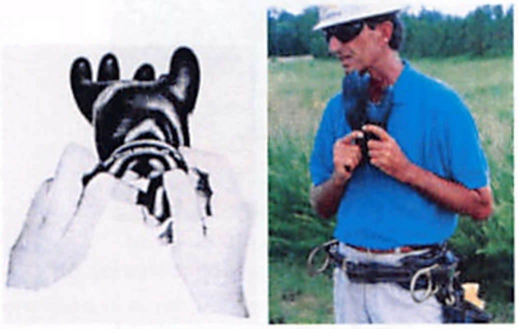
Daily Inflation Test

Gloves should also be air inflated to check for holes, punctures, tears and other damage

This can be accomplished by rolling...



...or by twirling



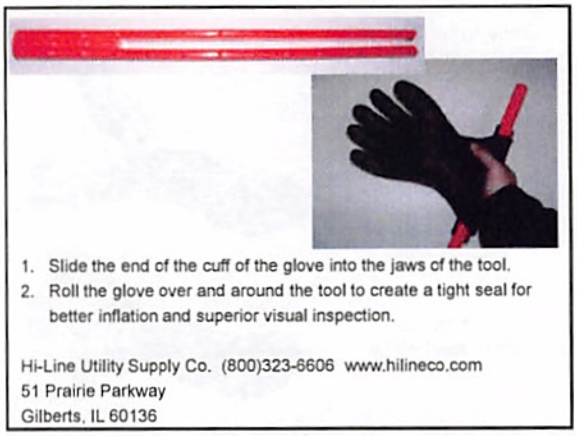
Daily Inflation Test

Gloves can also be inflated using a portable inflator

Daily Inflation Test

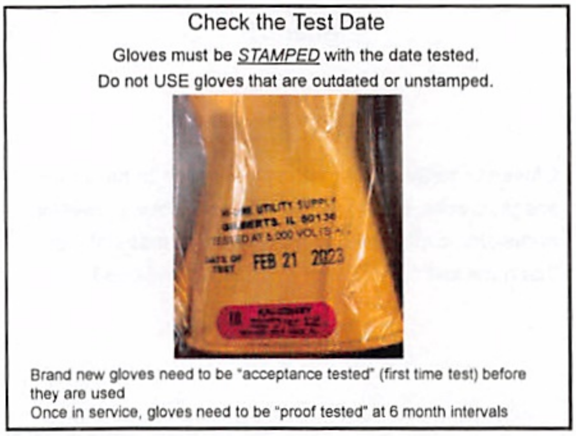
After rolling or twirling the edge of the glove to trap air, listen and feel for air escaping...

DISCARD GLOVE IF ANY LEAK IS DETECTED



1. Slide the end of the cuff of the glove into the jaws of the tool.
2. Roll the glove over and around the tool to create a tight seal for better inflation and superior visual inspection.

Hi-Line Utility Supply Co. (800)323-6606 www.hilineco.com
51 Prairie Parkway
Gilberts, IL 60136



Check the Test Date

Gloves must be *STAMPED* with the date tested.
Do not USE gloves that are outdated or unstamped.

Brand new gloves need to be "acceptance tested" (first time test) before they are used
Once in service, gloves need to be "proof tested" at 6 month intervals

Article 130.7(C)(7)(c) – Rubber Insulating Equipment Maximum Testing Intervals

Rubber insulating Equipment	When to test	ASTM standard for testing
Blankets	Before first issue and every 12 months thereafter	ASTM F 479
Covers	If insulating value is suspect	ASTM F 478
Gloves	Before first issue and every 6 months thereafter	ASTM F 496
Sleeves	Before first issue and every 12 months thereafter	ASTM F 496
Line hose	If insulating value is suspect	ASTM F 478

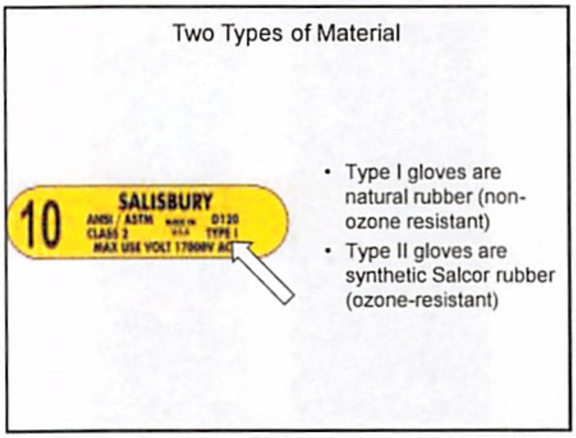
TESTED AT 20,000 VOLTS A.C.
FEB 21 2023
10
SALISBURY

Selecting the proper glove

- The "Class" of glove is based on voltage exposure.

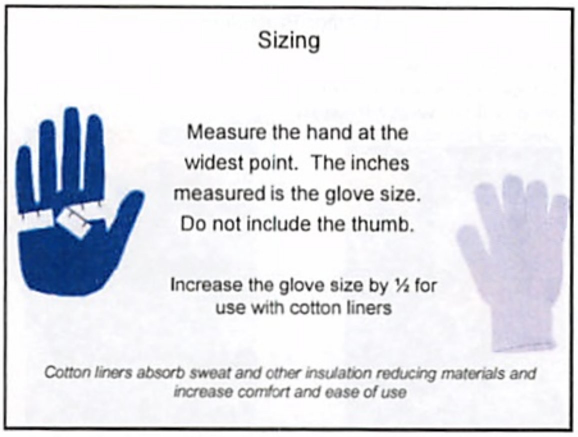
These gloves are for electrical exposures only. They are not to be used for chemical, or any other protection purposes.

Beige	Class 00	500 volts
Red	Class 0	1 kv
White	Class 1	10kV use to 7,500 volts
Yellow	Class 2	20kV use to 17 kv
Green	Class 3	30kV use to 26,500 volts
Orange	Class 4	40kV use to 36,000 volts



Two Types of Material

- Type I gloves are natural rubber (non-ozone resistant)
- Type II gloves are synthetic Salcor rubber (ozone-resistant)

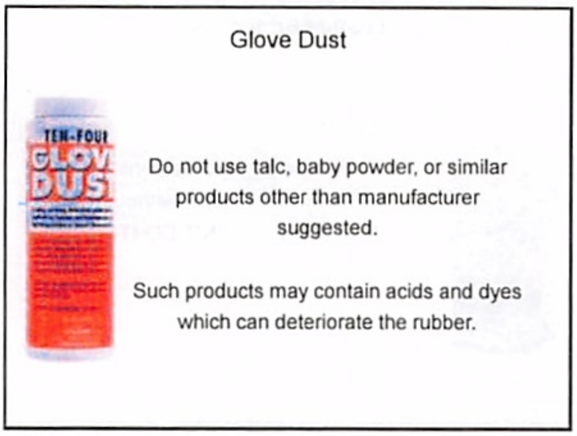


Sizing

Measure the hand at the widest point. The inches measured is the glove size. Do not include the thumb.

Increase the glove size by ½ for use with cotton liners

Cotton liners absorb sweat and other insulation reducing materials and increase comfort and ease of use

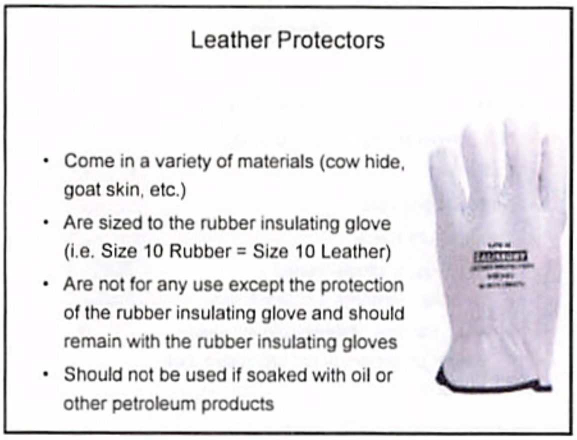


Glove Dust

TEN-FOUR
GLOVE
DUST

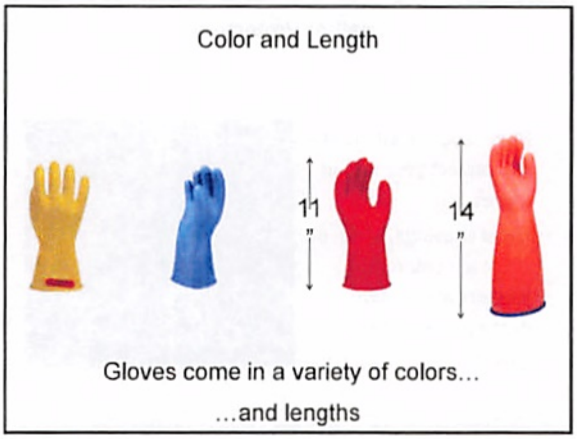
Do not use talc, baby powder, or similar products other than manufacturer suggested.

Such products may contain acids and dyes which can deteriorate the rubber.



Leather Protectors

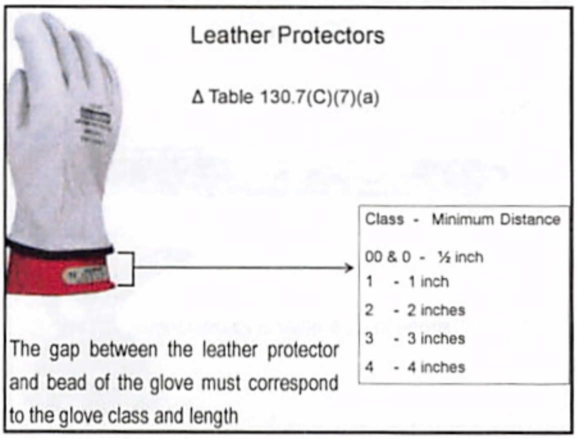
- Come in a variety of materials (cow hide, goat skin, etc.)
- Are sized to the rubber insulating glove (i.e. Size 10 Rubber = Size 10 Leather)
- Are not for any use except the protection of the rubber insulating glove and should remain with the rubber insulating gloves
- Should not be used if soaked with oil or other petroleum products



Color and Length

Gloves come in a variety of colors…

…and lengths

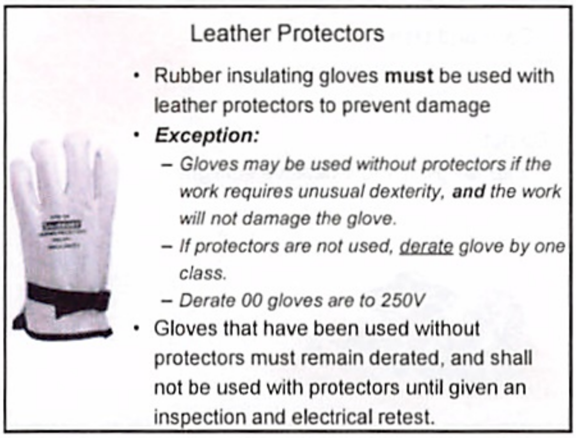


Leather Protectors

Δ Table 130.7(C)(7)(a)

Class -	Minimum Distance
00 & 0 -	½ inch
1 -	1 inch
2 -	2 inches
3 -	3 inches
4 -	4 inches

The gap between the leather protector and bead of the glove must correspond to the glove class and length



Leather Protectors

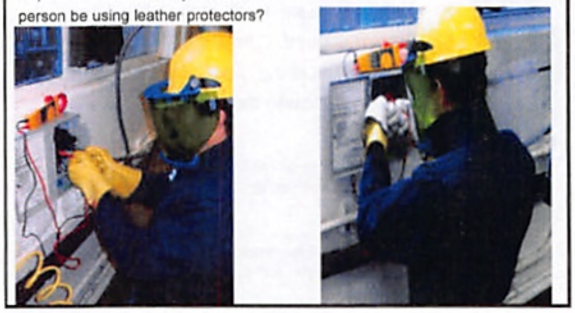
- Rubber insulating gloves **must** be used with leather protectors to prevent damage
- ***Exception:***
  - *Gloves may be used without protectors if the work requires unusual dexterity,* ***and*** *the work will not damage the glove.*
  - *If protectors are not used, derate glove by one class.*
  - *Derate 00 gloves are to 250V*
- Gloves that have been used without protectors must remain derated, and shall not be used with protectors until given an inspection and electrical retest.

Leather Protectors

- Bottom Line
  - There are some conditions where you can work without the leathers, but DON'T DO IT!

Leather Protectors

What do you think? Will this work damage the glove? Does this work require unusual dexterity? Should this person be using leather protectors?



Leather Protectors

- Protect your leathers like you protect your rubber gloves
- Metal shavings, sand, oil, etc. can compromise leathers and in turn damage the rubber gloves

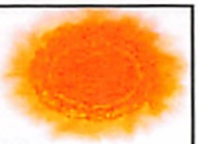
Storage

Gloves must be properly stored:

- In a canvas storage bag (1 pr./ bag)
- Cuff down
- As flat as possible
- Cool and dry place
- Only gloves, or glove-related peripherals...leathers & cotton liners
  - Note: Storage of rubber gloves inside leather protectors is not prohibited, but not recommended

ALWAYS WEAR YOUR GLOVES

Care and Use

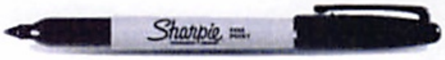


Do not:

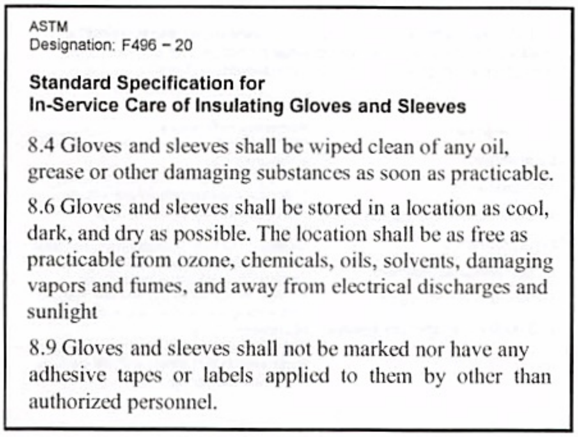
- Expose gloves to extensive sunlight

Care and Use

Do not: Write on them



Do not: Expose to oil & other contaminants



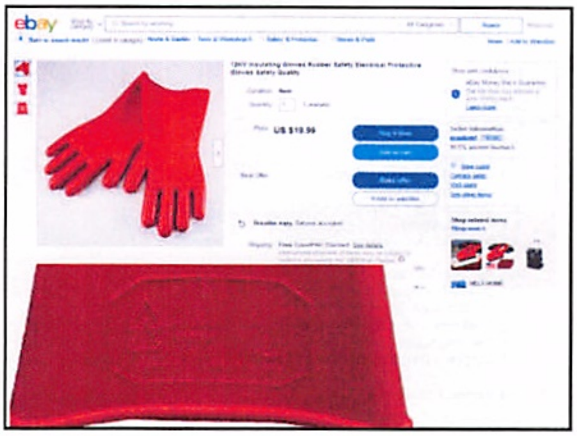
ASTM
Designation: F496 – 20

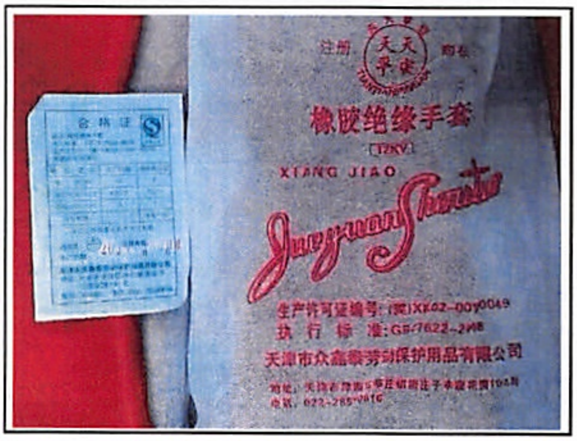
Standard Specification for In-Service Care of Insulating Gloves and Sleeves

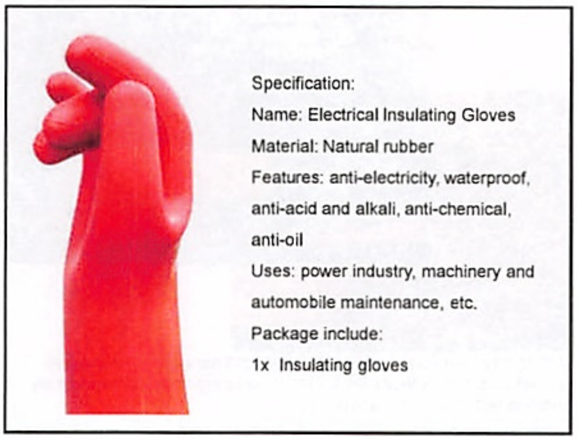
8.4 Gloves and sleeves shall be wiped clean of any oil, grease or other damaging substances as soon as practicable.

8.6 Gloves and sleeves shall be stored in a location as cool, dark, and dry as possible. The location shall be as free as practicable from ozone, chemicals, oils, solvents, damaging vapors and fumes, and away from electrical discharges and sunlight

8.9 Gloves and sleeves shall not be marked nor have any adhesive tapes or labels applied to them by other than authorized personnel.







Specification:

Name: Electrical Insulating Gloves

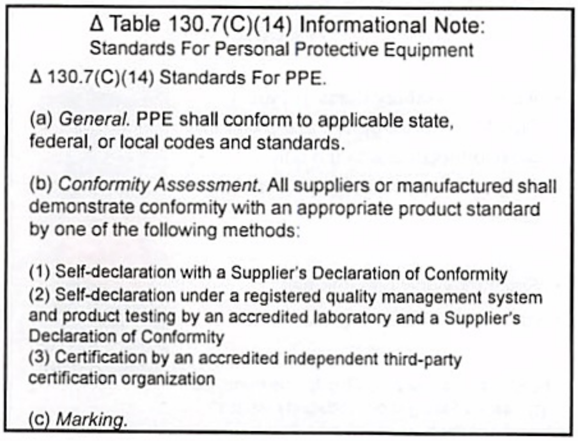
Material: Natural rubber

Features: anti-electricity, waterproof, anti-acid and alkali, anti-chemical, anti-oil

Uses: power industry, machinery and automobile maintenance, etc.

Package include:

1x Insulating gloves



Δ Table 130.7(C)(14) Informational Note:
Standards For Personal Protective Equipment

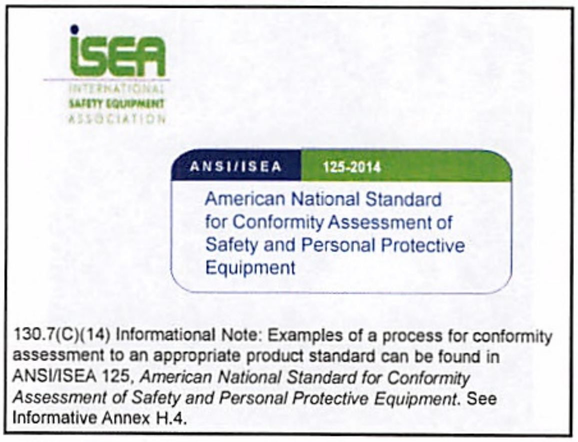
Δ 130.7(C)(14) Standards For PPE.

(a) *General.* PPE shall conform to applicable state, federal, or local codes and standards.

(b) *Conformity Assessment.* All suppliers or manufactured shall demonstrate conformity with an appropriate product standard by one of the following methods:

(1) Self-declaration with a Supplier's Declaration of Conformity
(2) Self-declaration under a registered quality management system and product testing by an accredited laboratory and a Supplier's Declaration of Conformity
(3) Certification by an accredited independent third-party certification organization

(c) *Marking.*


ISEA
INTERNATIONAL SAFETY EQUIPMENT ASSOCIATION

ANSI/ISEA 125-2014
American National Standard for Conformity Assessment of Safety and Personal Protective Equipment

130.7(C)(14) Informational Note: Examples of a process for conformity assessment to an appropriate product standard can be found in ANSI/ISEA 125, *American National Standard for Conformity Assessment of Safety and Personal Protective Equipment*. See Informative Annex H.4.

ANSI/ISEA 125 (International Safety Equipment Association)

1. Scope
2. Normative References
3. Definitions
4. Application
5. Compliance
6. Requirements for Level 1.
    6.1 Quality Management System
    6.2 Conformance Testing
    6.3 Corrective and Preventive Action
    6.4 Recordkeeping
    6.5 Supplier's Declaration of Conformity

7. Requirements for Level 2
    7.1 Quality Management System
    7.2 Conformance Testing
    7.3 Corrective and Preventive Action
    7.4 Recordkeeping
    7.5 Supplier's Declaration of Conformity

8. Requirements for Level 3 ....

1.1 This standard establishes criteria for "**conformity assessment**" of safety and personal protective equipment which is sold with claims of compliance with product performance standards.

3.1 accreditation.

3.2 attestation.

3.3 certification.

3.4 certification organization.

3.6 conformance.

3.7 conformity assessment.

3.9 independent third party.

3.10 quality management system.

Normative References

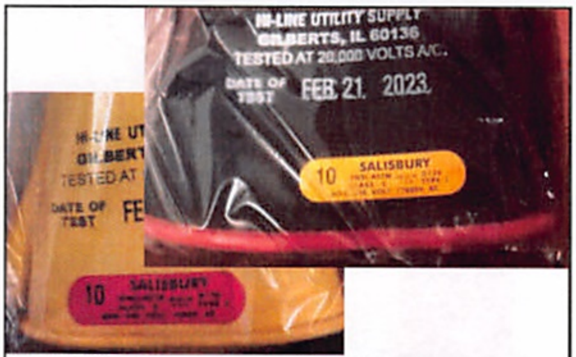
ISO 9001:2008, *Quality management systems – Requirements,*

ISO/IEC 17011:2004, *Conformity assessment – General requirements for accreditation bodies accrediting conformity assessment bodies*

ISO/IEC 17021:2011, *Conformity assessment – requirements for bodies providing audit and certification of management systems*

ISO/IEC 17025:2005, General requirements for the competence of testing and calibration laboratories

ISO/IEC17065:2012, Conformity assessment – Requirements for bodies certifying products, processes and service



ASTM D120 – marked right on the product! That's all OSHA requires as well as the in service care & use (periodic proof test, including daily inflation test, and daily inspection).

Lets look at an actual arc flash/arc blast on a maintenance/repair job.

2 alleged qualified electrical workers

This job required changing a circuit breaker on a main distribution panel. Since this panel was feeding the entire building, it was decided to do this job energized/hot in order to avoid inconveniencing the tenants with a power outage.

The PPE

- A pair of Salisbury Class 1, Type 1, Size 11 electrical gloves and a pair of glove protectors, was the only Personal Protective Equipment being used.

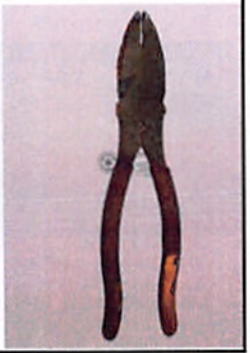
- Since they only had one pair

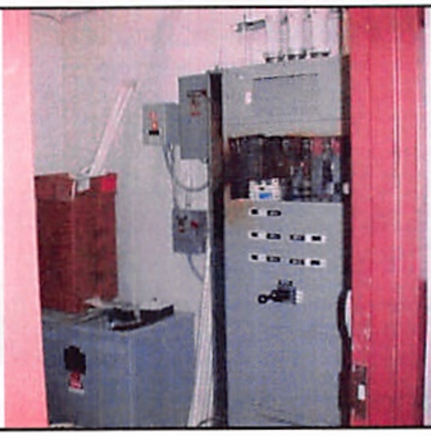
Each worker wore one glove.

The glove was much too big for his hand, as you saw it fall right off...dexterity issues?

Incident Information

- One worker grabbed a pair of pliers and the left glove to secure (keep from moving) the "live finger" while the screw was being removed. The pliers slipped and the live finger created an arc (phase to phase).





Effects of the Incident

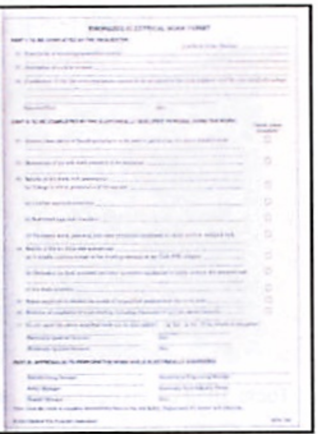
- One worker had 1st 2nd and 3rd degree burns and was hospitalized for 6 weeks with several months of physical and psychological therapy.
- Journeyman also suffered 1st 2nd & 3rd degree burns but very limited.

Do you remember why we did this energized?

Article 130.2

When work is performed …an energized electrical work permit shall be required…

Annex J



Did these workers do any of this?

Insulated/Insulating Hand Tools

130.7(C)(1), Article 245
1910.335(a)(2)(i)

Insulat*ed* hand tools – tools covered with insulating material to minimize the risk of short circuits with energized parts

Insulat*ing* hand tools – tools made from insulating material, except for metal inserts at the active part, or used for reinforcement, with no exposed metal parts.

To prevent arc flash/arc blast from short circuits using hand tools.

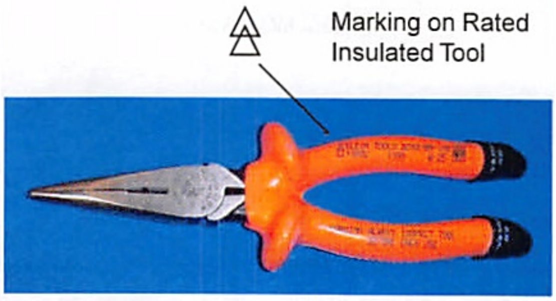
Non - Rated Tools with Cushion – Grip Handles

These are not insulated tools

Insulated/Insulating Hand Tools

This does not identify an insulated/insulating tool!

Marking on Rated Insulated Tool



Insulated Hand Tools have only one voltage rating 1000v

Rated Insulated Tools

Tools shall be inspected for damage before each use

Insulated/Insulating Hand Tools (page 38)

Δ 130.7(D)(1) Insulated Tools and Equipment. Tools and handling equipment used within the restricted approach boundary shall be insulated. Insulated tools shall be protected from damage to the insulating material.

Do you have insulated tools?

How do you treat them?

Have you inspected them lately?

Note: *Other low voltage hazards may exist that require the use of insulated/insulating tools, such as around batteries*

130.5 Arc Flash Hazard Analysis ~~Risk Assessment~~.

130.5(A) An arc flash hazard analysis shall be performed:

(1) To identify arc flash hazards

(2) To estimate the likelihood of occurrence of injury or damage to health

(3) To determine if additional the protective measured are required, including the use of PPE

130.5 Arc Flash Hazard Analysis ~~Risk Assessment~~.

130.5(B) ~~Estimate of likelihood and severity.~~

Δ *130.5*(C) Additional Protective Measures. (boundary & PPE Levels)

130.5(D) Documentation. The results of the arc flash risk assessment shall be documented. (Energized Electrical Work Permit)

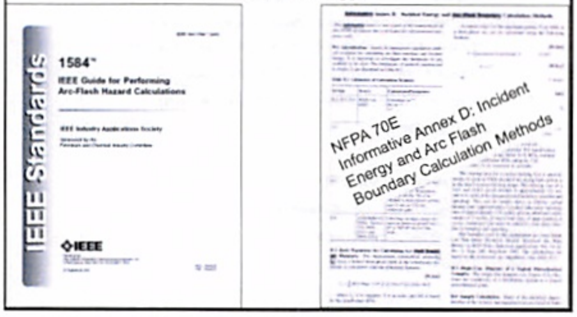
130.5(E) Arc Flash Boundary.

(1) The arc flash boundary shall be the distance at which the incident energy equals 1.2 cal/cm^2 (5 J/cm^2).

(2) The arc flash boundary shall be permitted to be determined by Table 130.7(C)(15)(a) or Table 130.7(C)(15)(b) when the requirements of these tables apply.

Arc Flash Hazard Calculations

The data is then used to calculate the available incident energy.


IEEE Standards
1584™
IEEE Guide for Performing Arc-Flash Hazard Calculations
IEEE Industry Applications Society
IEEE

NFPA 70E
Informative Annex D: Incident Energy and Arc Flash Boundary Calculation Methods

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The incident energy analysis method
Arc Flash Hazard Calculations

What's involved?

Detailed information is acquired on the electrical system:

- Utility specifics
- Transformer specs – kva/mva, phase, %Z
- Conductor size, type, length, number/phase
- Conduit type
- Overcurrent device size, type, rating, trip settings
- Etc., etc..

Article 130.7(C) – Personal and Other Protective Equipment

130.7(A) Employees ..shall be provided with, and shall use, protective equipment that is designed and constructed for the specific part of the body to be protected and for the work to be performed.

(B) Care of Equipment.

Review 130.7(C) PPE

1. General
2. Movement and Visibility
3. Head, Face Neck and chin (head area) protection
4. Eye Protection
5 Hearing Protection
6. Body Protection
Δ 7. Hand and Arm Protection
Δ 8. Foot Protection
9. Factors in Selecting Clothing

Δ 10. Arc Flash Protective Equipment
11. Clothing Material Characteristics
12. Clothing Not Permitted
13. Care and Maintenance of Arc Rated Clothing and Arc Rated Flash Suits
Δ 14. Standards for PPE
(Formerly ASTM standards)
Informational Note Table 130.7(C)(14)
Δ Selection of PPE (Table C15(c)
PPE (HRC-material weights-cal/cm²)

Δ Article 100 – Definitions

Arc Rating. The value attributed to materials that describes their performance to exposure to an electrical arc discharge.

The arc rating is expressed in cal/cm² and is derived from the determined value of the arc thermal performance value (ATPV)...

Informational Note No. 1-3 ASTM F1959

No1. Arc rated clothing is also flame resistant.

ASTM F1506 Standard Performance Specification for Flame Resistant and Arc Rated Textile Materials for Use by Electrical Workers Exposed to Momentary Electric Arc and Related Thermal Hazards

ASTM F1506 Must pass a test calculating the energy likely to cause a second degree burn to result through the fabric 50% of the time. Rating is expressed as ATPV (Arc Thermal Performance Value) calories/cm²

ASTM F1959 Standard Test Method for Determining the Arc Rating of Material for Clothing

NFPA 2112 Standard on Flame-Resistant Garments for Protection of Industrial Personnel Against Flash Fire (National Fire Protection Association)

NFPA 2112 Fabrics tested to pass a test of no less than 50% second and third degree body burn in a three second flash fire. Rating expressed as a % body burn rather than calories.

Typical Arc Rated clothing is 88/12 FR 88% cotton 12% synthetic/nylon but must have an ATPV rating tested to ASTM F1506

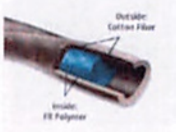
ASTM F1506 Arc Rating Testing based on fabric laundered 25 times

ELECTRICAL
PROTECTIVE

Performance (protection as PPE)
Comfort
Service life (how long will it last)

UltraSoft®, UltraSoft AC® and Indura®

Manufactured by Westex
guarantee of flame resistance for the life of the garment



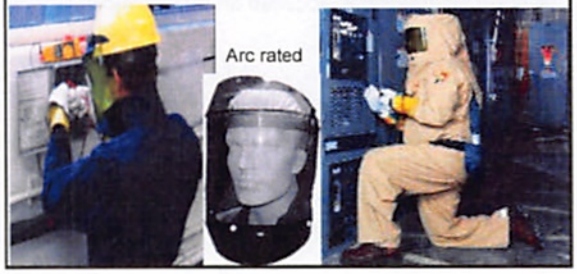
In the Westex engineering process, phosphonium salt precondensate flame retardant chemical is applied and polymerized with gaseous ammonia. This forms a long-chain flame retardant polymer impregnated into the core of each cotton fiber. The polymer acts as a catalyst promoting the charring of the fabric; the accelerated charring prohibits the support of combustion by reducing the fuel source.

Textile Clothing - NFPA 70E & ASTM F1506

"Hazard Risk Category Classifications"
PPE Categories 1 – 4 required for the task.

PPE Category 1

PPE Category 4



Arc rated

Table 130.7(C)(15)(c) Personal Protective Equipment (PPE)

PPE Category 1 - Arc Rated Clothing Minimum Arc Rating of 4 cal/cm^2

ATPV Arc Thermal Performance Value – See Arc Rating Art.100

Arc - rated long sleeve shirt and pants or arc-rated coverall

Arc-rated face shield (note 2) or arc flash suit hood

Arc rated jacket, parka, rainwear or hard hat liner (AN)

Protective Equipment:

Hard Hat

Safety glasses or goggles (SR)

Hearing protection (ear canal inserts)

Heavy duty leather gloves (Note 3)

Leather footwear (AN)

Table 130.7(C)(15)(c) Personal Protective Equipment (PPE)

PPE Category 2 - Arc Rated Clothing Minimum Arc Rating of 8 cal/cm^2

Arc - rated long sleeve shirt and pants or arc-rated coverall

Arc-rated flash suit hood or arc rated face shield (note 2) and arc rated balaclava

Arc rated jacket, parka, rainwear or hard hat liner (AN)

Protective Equipment:

Hard Hat

Safety glasses or goggles (SR)

Hearing protection (ear canal inserts)

Heavy duty leather gloves (note 3)

Leather footwear (AN)

- a flash suit hood or alternatively a face shield used in combination with an arc rated balaclava (sock hood) is required for this task…

Arc rated balaclava required by 130.7(C)(10)(b)(1)

Arc rated hair and beard nets required by 130.7(C)(3)

TRACKING #
C50599
6 OZ ULTRA SOFT
RIB KNIT
ARC RATING
Made in the U.S.A.

Table 130.7(C)(15)(c) Personal Protective Equipment (PPE)

PPE Category 3 - Arc Rated Clothing System
Minimum Arc Rating of 25 cal/cm^2

Arc - rated long sleeve shirt (AR)

Arc –rated pants (AR)

Arc-rated flash suit jacket (AR)

Arc-rated flash suit pants (AR)

Arc-rated flash suit hood

Arc-rated gloves (note 1)

Arc rated jacket, parka, rainwear or hard hat liner (AN)

Protective Equipment: Hard Hat, Safety glasses or goggles (SR), Hearing protection (ear canal inserts), Leather footwear

Table 130.7(C)(15)(c) Personal Protective Equipment (PPE)

PPE Category 4 - Arc Rated Clothing System
Minimum Arc Rating of 40 cal/cm²

Arc - rated long sleeve shirt (AR)
Arc –rated pants (AR)
Arc-rated flash suit jacket (AR)
Arc-rated flash suit pants (AR)
Arc-rated flash suit hood
Arc rated gloves (note 1)
Arc rated jacket, parka, rainwear or hard hat liner (AN)
Protective Equipment: Hard Hat, Safety glasses or goggles (SR), Hearing protection (ear canal inserts), Leather footwear

---

PPE Category 1 = 4 cal/cm² (ATPV – arc thermal performance value)

PPE Category 2 = 8 cal/cm² (ATPV – arc thermal performance value)

PPE Category 3 = 25 cal/cm² (ATPV – arc thermal performance value)

PPE Category 4 = 40 cal/cm² (ATPV – arc thermal performance value)

Δ110.2(B) When Required.

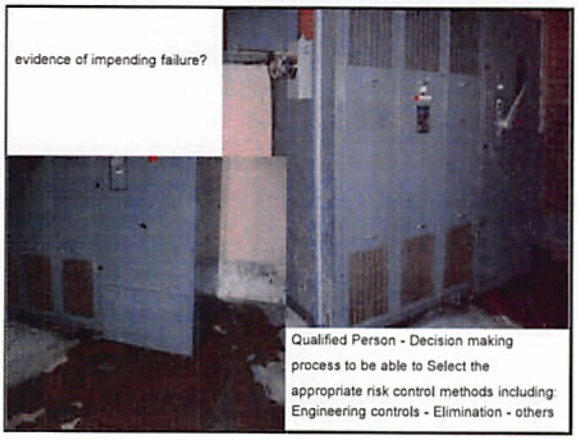
Exception No. 1: Normal operation of electrical equipment shall be permitted where a normal operation condition exists.
A normal operating condition exists when all of the following conditions are satisfied.

(1) The equipment is properly installed.
(2) The equipment is rated for the available fault current.
(3) The equipment is properly maintained.
(4) The equipment is used in accordance with instructions included in the listing and labeling and in accordance with manufacturer's instructions.
(5) The equipment doors are closed and secured.
(6) All equipment covers are in place and secured.
(7) There is no evidence of impending failure.

Table 130.5(C) Estimate of the Likelihood of Occurrence of Arc-Flash Incident for as and dc Systems

	Operating Condition[a]	Likelihood of Occurrence[b]
Operation of a CB, switch, starter…	Normal	No
	Abnormal	Yes

Opening a panelboard hinged door
To access dead front overcurrent devices

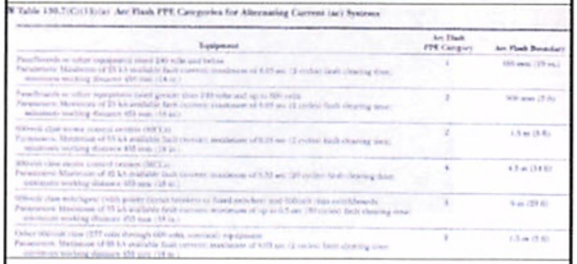


evidence of impending failure?

Qualified Person - Decision making process to be able to Select the appropriate risk control methods including: Engineering controls - Elimination - others

---

Working on a 120v/240v panel



Working on a 480v panel.
Working on a MCC.

Table 130.7(C)(15)(c) Personal Protective Equipment (PPE)

PPE Category 1 - Arc Rated Clothing Minimum Arc Rating of 4 cal/cm^2

ATPV Arc Thermal Performance Value – See Arc Rating Art.100

Arc - rated long sleeve shirt and pants or arc-rated coverall

Arc-rated face shield (note 2) or arc flash suit hood

Arc rated jacket, parka, rainwear or hard hat liner (AN)

Protective Equipment:

Hard Hat

Safety glasses or goggles (SR)

Hearing protection (ear canal inserts)

Heavy duty leather gloves (Note 3)

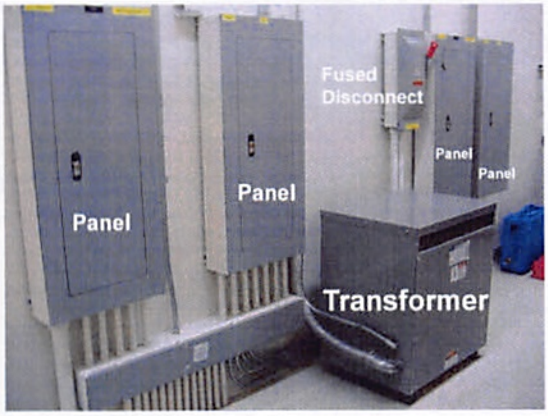
Leather footwear (AN)

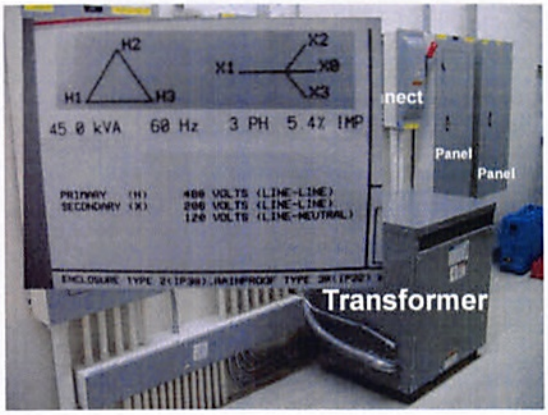
Arc Flash Hazard Calculations

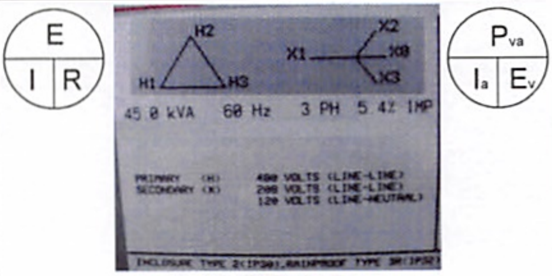
What's involved?

Detailed information is acquired on the electrical system:

- Transformer specs – kva/mva, phase, %Z
- Conductor size, type, length, number/phase
- Conduit type
- Overcurrent device size, type, rating, settings
- Etc., etc., etc.


Fused Disconnect
Panel
Panel
Panel
Panel
Transformer


H2
X2
X1
X0
H1
H3
X3
45.0 kVA 60 Hz 3 PH 5.4% IMP
PRIMARY (H)
SECONDARY (X)
480 VOLTS (LINE-LINE)
208 VOLTS (LINE-LINE)
120 VOLTS (LINE-NEUTRAL)
ENCLOSURE TYPE 2(IP30),RAINPROOF TYPE 3R(IP32)
nect
Panel
Panel
Transformer


E
I
R
H2
X2
X1
X0
H1
H3
X3
45.0 kVA 60 Hz 3 PH 5.4% IMP
PRIMARY (H)
SECONDARY (X)
480 VOLTS (LINE-LINE)
208 VOLTS (LINE-LINE)
120 VOLTS (LINE-NEUTRAL)
ENCLOSURE TYPE 2(IP30),RAINPROOF TYPE 3R(IP32)
P$_{va}$
I$_a$
E$_v$

What's the FLA

$$\frac{VA}{V \times 1.73} = \frac{45\text{ kVA} \times 1000}{208V \times 1.73} = \frac{45{,}000}{359.84} = 125\text{ FLA}$$

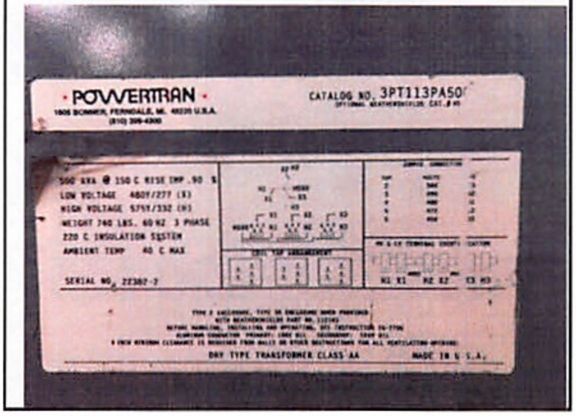
Calculating Fault Current

- $Isc = \dfrac{kva \times 1000}{V \times 1.73 \times Impedance}$

$$Isc = \frac{45\text{ kva} \times 1000}{208\text{ V} \times 1.73 \times 0.054} = 2{,}316\text{ amps}$$

Converting percent to decimal simply remove the percent sign and divide by 100

Table 130.7 (C)(15)(a) Arc Flash Categories for Alternating Current (ac) Systems Including Arc Flash Boundary



· POWERTRAN ·

CATALOG NO. 3PT113PA50

500 KVA @ 150 C RISE IMP .90 %

LOW VOLTAGE 480Y/277 (X)

HIGH VOLTAGE 575Y/332 (H)

WEIGHT 740 LBS. 60 HZ 3 PHASE

220 C INSULATION SYSTEM

AMBIENT TEMP 40 C MAX

SERIAL NO. 22382-2

DRY TYPE TRANSFORMER CLASS AA MADE IN U.S.A.

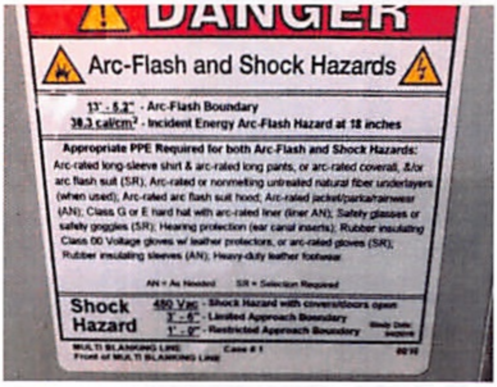
Calculating Fault Current

- $$I_{sc} = \frac{kva \times 1000}{V \times 1.73 \times Impedance}$$

Converting percent to decimal simply remove the percent sign and divide by 100

$$I_{sc} = \frac{500kva \times 1000}{480\ V \times 1.73 \times .009Z} \qquad \frac{500{,}000va}{7.4736}$$

$= 66,902$ amps



DANGER

Arc-Flash and Shock Hazards

13' - 5.2" - Arc-Flash Boundary

30.3 cal/cm² - Incident Energy Arc-Flash Hazard at 18 inches

Appropriate PPE Required for both Arc-Flash and Shock Hazards:

Arc-rated long-sleeve shirt & arc-rated long pants, or arc-rated coverall, &/or arc flash suit (SR); Arc-rated or nonmelting untreated natural fiber underlayers (when used); Arc-rated arc flash suit hood; Arc-rated jacket/parka/rainwear (AN); Class G or E hard hat with arc-rated liner (liner AN); Safety glasses or safety goggles (SR); Hearing protection (ear canal inserts); Rubber insulating Class 00 Voltage gloves w/ leather protectors, or arc-rated gloves (SR); Rubber insulating sleeves (AN); Heavy-duty leather footwear

AN = As Needed SR = Selection Required

Shock Hazard

480 Vac - Shock Hazard with covers/doors open

3' - 6" - Limited Approach Boundary

1' - 0" - Restricted Approach Boundary

MULTI BLANKING LINE Case # 1

Front of MULTI BLANKING LINE

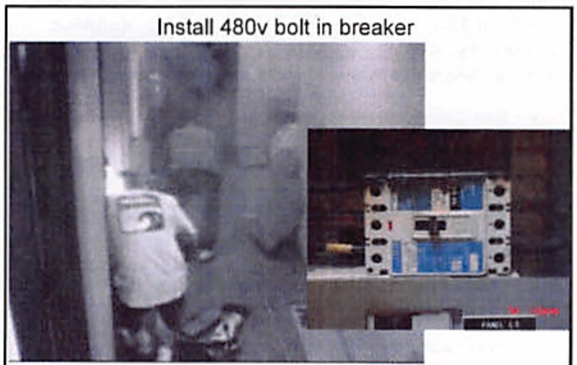
PPE Category 1 = 4 cal/cm² (ATPV – arc thermal performance value)

PPE Category 2 = 8 cal/cm² (ATPV – arc thermal performance value)

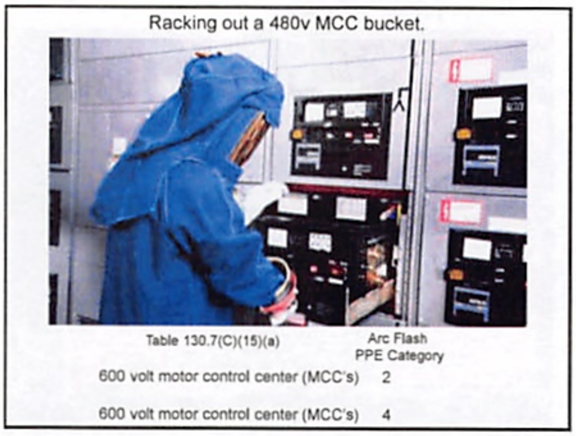
PPE Category 3 = 25 cal/cm² (ATPV – arc thermal performance value)

PPE Category 4 = 40 cal/cm² (ATPV – arc thermal performance value)

Install 480v bolt in breaker



Δ Table 130.7(C)(15)(a) Arc Flash PPE Categories for ac Systems



Racking out a 480v MCC bucket.

Table 130.7(C)(15)(a)	Arc Flash PPE Category
600 volt motor control center (MCC's)	2
600 volt motor control center (MCC's)	4

Article 130.7(C)(13) – PPE Care and Maintenance of Arc-Rated Clothing and Arc-Rated Flash Suits.

- Shall be inspected before each use.
- Contaminated or damaged clothing or arc flash suits shall not be used.
- Care maintenance and cleaning – per mfg. instructions.
- Stored in a manner that prevents physical damage from moisture, dust, or other deteriorating agents or contamination.

Article 130.7(C)(13) – PPE Care and Maintenance

ASTM F2757 - 09 Standard Guide for Home Laundering Care and Maintenance of Flame, Thermal and Arc Resistant Clothing

- Soft water preferred to hard water
- Always follow the care label.
- Turn garments inside out when laundering.
- Do not use chlorine bleach, hydrogen peroxide, starch, or fabric softeners
- Detergent / No Soap Use household laundry detergents
- Do not use fatty based or bar soaps
- Wash with other FR / Arc Rated only
- Dry on medium heat cycle

ASTM F2757 - 09 Standard Guide for Home Laundering Care and Maintenance of Flame, Thermal and Arc Resistant Clothing

Removal from Service— For most practical purposes, garments may be temporarily or permanently removed from service for reasons as determined by inspection based on subjective evaluation. Ultimately, determination of when flame, thermal and arc resistant clothing should be removed from service is the responsibility of the end user.

ASTM F2757 – 09 Standard Guide for Home Laundering Care and Maintenance of Flame, Thermal and Arc Resistant Clothing

The following items, identifiable by visual examination, may diminish the effectiveness of the flame, thermal, and arc resistant clothing. Other issues may also have such effects.

Worn Out - Thin spots, holes, excessive wear or abrasion – for example on elbow or knee area.

Mechanical Damage - Evidence of cuts, rips, tears, open seams, and nonfunctional closures.

Modifications - Alteration(s) to a garment that differs significantly from the original design.

Fit - The flame, thermal, and arc resistant clothing no longer fits the wearer.

Flammable Substances - Garments soiled by substances that represent a flammability risk, such as solvents, solids, oils, and other petroleum products that cannot be properly removed by cleaning.

The presence of a petroleum or chemical odor can be evidence of a flammable substance.

130.5(H) Equipment Labeling. Shall be field marked with a label containing:

DANGER
Arc-Flash and Shock Hazards
Shock Hazard

1. Nominal voltage
2. Arc flash boundary
3. At least one of the following:
   - a) Incident energy level & working distance or PPE category
   - b) Minimum arc rating of clothing required
   - c) Site-specific level of PPE

The method of calculating and the data to support the information for the label shall be documented. Shall be reviewed and updated for accuracy at intervals not exceeding 5 years.

The intent of this standard does not require homeowners to install labels but anyone performing work needs to do the risk assessments.

130.5(H) Equipment Labeling

The method of calculating and the data to support the information for the label shall be documented. The data shall be reviewed for accuracy at intervals not to exceed 5 years. Where the review of the data identifies a change that renders the label inaccurate, the label shall be updated.

The owner of the electrical equipment shall be responsible for the documentation, installation, and maintenance of the marked label.

Many of the things we talked about will require changes in your thinking...you must WANT to do this for YOUR well-being...

I would remind you to consider what impact an accident would have on your family & loved ones.

Where we started at the begining of this training

Article 105 - Application of Safety-Related Work Practices

105.3 Employer Responsibility. The employer shall provide employees with training in the safety-related work practices and procedures.

Employee Responsibility. The employee shall comply with the safety related work practices and procedures provided by the employer.

You are empowered to protect yourself!
All you have to do is apply what you
learned here about OSHA & NFPA 70E!

Safe Travels &
Be safe out there !

Grizzy

Electrical Meter Category Ratings

Overvoltage Category	In Brief	Examples
CAT IV	Three-phase at utility connection, any outdoor conductors	• Refers to the "origin of installation"; i.e., where low-voltage connection is made to utility power. • Electricity meters, primary overcurrent protection equipment. • Outside and service entrance, service drop from pole to building, run between meter and panel. • Overhead line to detached building, underground line to well pump
CAT III	Three-phase distribution, including single-phase commercial lighting	• Equipment in fixed installations, such as switchgear and polyphase motors. • Bus and feeder in industrial plants. • Feeders and short branch circuits, distribution panel devices. • Lighting systems in larger buildings. • Appliance outlets with short connections to service entrance.
CAT II	Single-phase receptacle connected loads	• Appliance, portable tools, and other household and similar loads. • Outlet and long branch circuits. • Outlets at more than 10 meters (30 feet) from CAT III source. • Outlets at more that 20 meters (60 feet) from CAT IV source.
CAT I	Electronic	• Protected electronic equipment. • Equipment connected to (source) circuits in which measures are taken to limit transient overvoltages to an appropriately low level. • Any high-voltage, low-energy source derived from a highwinding resistance transformer, such as the high-voltage section of a copier.

Ratings based on IEC 61010

Measurement Category	Working Voltage to Ground (dc or RMS)	Peak Impulse - Transient	Test Source (Ω = V/A)
CAT I	600 V	2500 V	30 Ohm Source
CAT I	1000 V	4000 V	30 Ohm Source
CAT II	600 V	4000 V	12 Ohm Source
CAT II	1000 V	6000 V	12 Ohm Source
CAT III	600 V	6000 V	2 Ohm Source
CAT III	1000 V	8000 V	2 Ohm Source
CAT IV	600 V	8000 V	2 Ohm Source

Remember that test leads are tested to a category rating also and must be matched to the meter.

1910.331-.335 Electrical Safety Related Work Practices Outline

Developed by: John "Grizzy" Grzywacz
Professor Emeritus
OSHA National Training Institute
oshaprofessor.com

1910.331-.335 OSHA ESRWP Outline

1910.331 Safety-related Work Practices

(a) Scope
(b) Unqualified persons
(c) Qualified persons

1910.332 Training

(a) Scope employees who face risk of shock
(b) Content of Training
  (b)(1) Practices addressed in this standard
  (b)(2) Additional requirements for unqualified persons
  (b)(3) Additional requirements for qualified persons
(c) Type of training

1910.333 Selection and use of Work Practices

(a) General
  (a)(1) Deenergized parts - Live parts SHALL be de-energized and locked out prior to working on them (exception: employer can prove greater hazard or infeasibility)
  (a)(2) Energized parts - must protect against ALL electrical hazards (shock, electrocution, burns, fire, explosion, & arc blast)
  (b)(1) Working on or near exposed energized parts
  (b)(2) Lockout and Tagging
  (c)(3) Overhead lines-clearances
  (c)(4) Illumination
  (c)(5) Confined work spaces
  (c)(6) Conductive materials and equipment
  (c)(7) Portable ladders
  (c)(8) Conductive apparel-jewelry
  (c)(9) Housekeeping
  (c)(10) Interlocks

1910.334 Use of Equipment

(a) Portable electrical equipment & cordsets (extension cords)
  (a)(1) Handling-flexible cords - not handled in a manner which will cause damage - don't use extension cords to raise or lower equipment
(a)(2) Visual inspection - daily or before use, employees trained to inspect for such things as damage to insulation, crushed outer jacket, missing broken or bent pins, any external defects or indications of internal defects Must be removed from service until repaired (procedures needed)
  (a)(3) Grounding - don't mess with the ground pin, its purpose is to prevent electrocution from equipment malfunction
(iii) Grounding adapters prohibited
  (a)(5) Connecting attachment plugs - no wet hands
  (b)(1) Power and Lighting circuits opening and closing of circuits
  (b)(2) Reclosing after protective device operation
  (b)(3) Overcurrent modification
  (c) Test instruments and equipment
  (c)(1) Use by qualified persons only
  (c)(2) Visual inspection - before each use
  (c)(3) Ratings - full rating for the circuits and equipment to which they will be used

(d) Flammable or ignitable materials

1910.335 Safeguards for personnel protection

(a)(1) PPE shall be used where there are potential electrical hazards (1910.132 requires hazard assessment equipment leather covers, dielectric head protection, eyes, face, electric arcs or flashes and electrical explosion. No synthetic or synthetic blend clothing can be worn

(a)(2) Insulated tools (must meet ASTM 1505) shall be used , fuse handlers, nonconductive ropes, protective shields and barriers, alerting techniques, safety signs and tags, barricades, attendants.

(b) Alerting techniques

(b)(1) Safety signs & tags
(b)(2) Barricades
(b)(3) Attendants

1910.399 Definitions

1910.331-.335 OSHA ESRWP Standards/70E – 2024 Edition Cross Reference

[Article references in brackets following OSHA's references are to the NFPA 70E® – 2024 Edition]

Disclaimer: Since this OSHA Electrical Safety Related Work Practices standard was promulgated in 1990 there have been 9 subsequent editions of NFPA 70E published. The evolution of revised language in 70E in some cases no longer mirrors the exact language that OSHA used from the earlier 70E. In these cases the closest applicable 70E reference with the same intent has been referenced here.

NOTE: Some more recent requirements contained in 70E are in violation of OSHA standard requirements and should be avoided in order to maintain OSHA regulatory compliance. [NFPA Disclaimer included in 70E]

1910.331(a) [90.3 (A),(B) 105.1, 2, 3]
Covered work by both qualified and unqualified persons. The provisions of 1910.331 through 1910.335 cover electrical safety work practices for both qualified persons (those who have training in avoiding the electrical hazards of working on or near exposed energized parts) and unqualified persons (those with little or no such training) working on, near, or with the following installations:

1910.331(a)(1) [90.3(A),(B)]
Premises wiring. Installations of electric conductors and equipment within or on buildings or other structures, and on other premises such as yards, carnival, parking, and other lots, and industrial substations;

1910.331(a)(2) [90.3(A),(B)]
Wiring for connection to supply. Installations of conductors that connect to the supply of electricity; and

1910.331(a)(3) [90.3(A),(B)]
Other wiring. Installations of other outside conductors on the premises.

1910.331(a)(4) [90.3(A),(B)]
Optical fiber cable. Installations of optical fiber cable where such installations are made along with electric conductors.
Note: See 1910.399 for the definition of "qualified person." See 1910.332 for training requirements that apply to qualified and unqualified persons.

1910.331(b) [90.3(A),(B)]
Other covered work by unqualified persons. The provisions of 1910.331 through 1910.335 also cover work performed by unqualified persons on, near, or with the installations listed in paragraphs (c)(1) through (c)(4) of this section.

1910.331(c) [90.3(A),(B)]

Excluded work by qualified persons. The provisions of 1910.331 through 1910.335 do not apply to work performed by qualified persons on or directly associated with the following installations:

1910.331(c)(1) [90.3(B)(4)(a)-(d)] **see 1910.269 & ANSI C-2-NESC**
Generation, transmission, and distribution of electric energy (including communication and metering) located in buildings used for such purposes or located outdoors.
Note 1: Work on or directly associated with installations of utilization equipment used for purposes other than generating, transmitting, or distributing electric energy (such as installations which are in office buildings, warehouses, garages, machine shops, or recreational buildings, or other utilization installations which are not an integral part of a generating installation, substation, or control center) is covered under paragraph (a)(1) of this section.
Note 2: For work on or directly associated with utilization installations, an employer who complies with the work practices of 1910.269 (electric power generation, transmission, and distribution) will be deemed to be in compliance with 1910.333(c) and 1910.335. However, the requirements of 1910.332, 1910.333(a), 1910.333(b), and 1910.334 apply to all work on or directly associated with utilization installations, regardless of whether the work is performed by qualified or unqualified persons.
Note 3: Work on or directly associated with generation, transmission, or distribution installations includes:
{1} Work performed directly on such installations, such as repairing overhead or underground distribution lines or repairing a feed-water pump for the boiler in a generating plant.
{2} Work directly associated with such installations, such as line-clearance tree trimming and replacing utility poles.
{3} Work on electric utilization circuits in a generating plant provided that:
{A} Such circuits are commingled with installations of power generation equipment or circuits, and
{B} The generation equipment or circuits present greater electrical hazards than those posed by the utilization equipment or circuits (such as exposure to higher voltages or lack of overcurrent protection).
This work is covered by 1910.269 of this Part.

1910.331(c)(2) [90.3(B)(3)]
Communications installations. Installations of communication equipment to the extent that the work is covered under 1910.268.

1910.331(c)(3) [90.3(B)(1)]
Installations in vehicles. Installations in ships, watercraft, railway rolling stock, aircraft or automotive vehicles other than mobile homes and recreational vehicles.

1910.331(c)(4) [90.3(B)(2)]
Railway installations. Installations of railways for generation, transformation, transmission, or distribution of power used exclusively for operation of rolling stock or installations of railways used exclusively for signaling and communication purposes.

1910.332 [110.4 (A)] **Training**
Scope. The training requirements contained in this section apply to employees who face a risk of electric shock that is not reduced to a safe level by the electrical installation requirements of 1910.303 through 1910.308.

Note: Employees in occupations listed in Table S-4 face such a risk and are required to be trained. Other employees who also may reasonably be expected to face comparable risk of injury due to electric shock or other electrical hazards must also be trained.

1910.332(b) **Content of training.**
1910.332(b)(1) [110.4(A)(1)-(5)]
Practices addressed in this standard. Employees shall be trained in and familiar with the safety-related work practices required by 1910.331 through 1910.335 that pertain to their respective job assignments.

1910.332(b)(2) [110.4(A)(3)]
Additional requirements for unqualified persons. Employees who are covered by paragraph (a) of this section but who are not qualified persons shall also be trained in and familiar with any electrically related safety practices not specifically addressed by 1910.331 through 1910.335 but which are necessary for their safety.

1910.332(b)(3) [110.4 (A)(3) & 110.4(B)(1),(2), 220.4(C)]
Additional requirements for qualified persons. Qualified persons (i.e. those permitted to work on or near

exposed energized parts) shall, at a minimum, be trained in and familiar with the following:

1910.332(b)(3)(i) [110.4(A)(1)(c)(1)]
The skills and techniques necessary to distinguish exposed live parts from other parts of electric equipment.

1910.332(b)(3)(ii) [110.4(A)(1)(c)(2)]
The skills and techniques necessary to determine the nominal voltage of exposed live parts, and

1910.332(b)(3)(iii) [110.4(A)(1)(c)(3)]
The clearance distances specified in 1910.333(c) and the corresponding voltages to which the qualified person will be exposed.

Note 1: For the purposes of 1910.331 through 1910.335, a person must have the training required by paragraph (b)(3) of this section in order to be considered a qualified person.
Note 2: Qualified persons whose work on energized equipment involves either direct contact or contact by means of tools or materials must also have the training needed to meet 1910.333(C)(2).

1910.332(c) [110.4(A)(4)]
Type of training. The training required by this section shall be of the classroom or on-the-job type. The degree of training provided shall be determined by the risk to the employee.
TABLE S-4. -- Typical Occupational Categories of Employees
Facing a Higher Than Normal Risk of Electrical Accident

Occupation
Blue collar supervisors(1)
Electrical and electronic engineers(1)
Electrical and electronic equipment assemblers(1)
Electrical and electronic technicians(1)
Electricians
Industrial machine operators(1)
Material handling equipment operators(1)
Mechanics and repairers(1)
Painters(1)
Riggers and roustabouts(1)
Stationary engineers(1)
Welders

Footnote(1) Workers in these groups do not need to be trained if their work or the work of those they supervise does not bring them or the employees they supervise close enough to exposed parts of electric circuits operating at 50 volts or more to ground for a hazard to exist.

1910.333(a) [110, 130.1]
General. Safety-related work practices shall be employed to prevent electric shock or other injuries resulting from either direct or indirect electrical contacts, when work is performed near or on equipment or circuits which are or may be energized. The specific safety-related work practices shall be consistent with the nature and extent of the associated electrical hazards.

1910.333(a)(1) [110.2(B), 120, 130.1]
Deenergized parts. Live parts to which an employee may be exposed shall be deenergized before the employee works on or near them, unless the employer can demonstrate that deenergizing introduces additional or increased hazards or is infeasible due to equipment design or operational limitations. Live parts that operate at less than 50 volts to ground need not be deenergized if there will be no increased exposure to electrical burns or to explosion due to electric arcs.
Note 1: Examples of increased or additional hazards include interruption of life support equipment, deactivation of emergency alarm systems, shutdown of hazardous location ventilation equipment, or removal of illumination for an area.
Note 2: Examples of work that may be performed on or near energized circuit parts because of infeasibility due to equipment design or operational limitations include testing of electric circuits that can only be performed with the

circuit energized and work on circuits that form an integral part of a continuous industrial process in a chemical plant that would otherwise need to be completely shut down in order to permit work on one circuit or piece of equipment.
Note 3: Work on or near deenergized parts is covered by paragraph (b) of this section.

1910.333(a)(2) [110.2(C), 130.1]
Energized parts. If the exposed live parts are not deenergized (i.e., for reasons of increased or additional hazards or infeasibility), other safety-related work practices shall be used to protect employees who may be exposed to the electrical hazards involved. Such work practices shall protect employees against contact with energized circuit parts directly with any part of their body or indirectly through some other conductive object. The work practices that are used shall be suitable for the conditions under which the work is to be performed and for the voltage level of the exposed electric conductors or circuit parts. Specific work practice requirements are detailed in paragraph (c) of this section.

1910.333(b) [110.2,] Working on or near exposed deenergized parts.

1910.333(b)(1) [110.2, 130.1]
Application. This paragraph applies to work on exposed deenergized parts or near enough to them to expose the employee to any electrical hazard they present. Conductors and parts of electric equipment that have been deenergized but have not been locked out or tagged in accordance with paragraph (b) of this section shall be treated as energized parts, and paragraph (c) of this section applies to work on or near them.

1910.333(b)(2) [110.2, 120,]
Lockout and Tagging. While any employee is exposed to contact with parts of fixed electric equipment or circuits which have been deenergized, the circuits energizing the parts shall be locked out or tagged or both in accordance with the requirements of this paragraph. The requirements shall be followed in the order in which they are presented (i.e., paragraph (b)(2)(i) first, then paragraph (b)(2)(ii), etc.).
Note 1: As used in this section, fixed equipment refers to equipment fastened in place or connected by permanent wiring methods.
Note 2: Lockout and tagging procedures that comply with paragraphs (c) through (f) of 1910.147 will also be deemed to comply with paragraph (b)(2) of this section provided that:
[1] The procedures address the electrical safety hazards covered by this Subpart; and
[2] The procedures also incorporate the requirements of paragraphs (b)(2)(iii)(D) and (b)(2)(iv)(B) of this section.

1910.333(b)(2)(i) [120.2, 3]
Procedures. The employer shall maintain a written copy of the procedures outlined in paragraph (b)(2) and shall make it available for inspection by employees and by the Assistant Secretary of Labor and his or her authorized representatives.
Note: The written procedures may be in the form of a copy of paragraph (b) of this section.

1910.333(b)(2)(ii) [120] Deenergizing equipment.

1910.333(b)(2)(ii)(A) [120.1 - 6]
Safe procedures for deenergizing circuits and equipment shall be determined before circuits or equipment are deenergized.

1910.333(b)(2)(ii)(B) [120.3(E)]
The circuits and equipment to be worked on shall be disconnected from all electric energy sources. Control circuit devices, such as push buttons, selector switches, and interlocks, may not be used as the sole means for deenergizing circuits or equipment. Interlocks for electric equipment may not be used as a substitute for lockout and tagging procedures.

1910.333(b)(2)(ii)(C) [120.5(B)(2), 120.5(B)(7)]
Stored electric energy which might endanger personnel shall be released. Capacitors shall be discharged and high capacitance elements shall be short-circuited and grounded, if the stored electric energy might endanger personnel.
Note: If the capacitors or associated equipment are handled in meeting this requirement, they shall be treated as energized.

1910.333(b)(2)(ii)(D) [120.5(B)(2)]
Stored non-electrical energy in devices that could reenergize electric circuit parts shall be blocked or relieved to the extent that the circuit parts could not be accidentally energized by the device.

1910.333(b)(2)(iii) [120.4, 120.5(B)(11)] **Application of locks and tags.**

1910.333(b)(2)(iii)(A) [70E only requires either a lock or a tag, not both]
A lock **and** a tag shall be placed on each disconnecting means used to deenergize circuits and equipment on which work is to be performed, except as provided in paragraphs (b)(2)(iii)(C) and (b)(2)(iii)(E) of this section. The lock shall be attached so as to prevent persons from operating the disconnecting means unless they resort to undue force or the use of tools.

1910.333(b)(2)(iii)(B) [120.4(D)(4),]
Each tag shall contain a statement prohibiting unauthorized operation of the disconnecting means and removal of the tag.

1910.333(b)(2)(iii)(C) [120.5(B)(11)(3)]
If a lock cannot be applied, or if the employer can demonstrate that tagging procedures will provide a level of safety equivalent to that obtained by the use of a lock, a tag may be used without a lock.

1910.333(b)(2)(iii)(D) [120.5(B)(11)(4)]
A tag used without a lock, as permitted by paragraph (b)(2)(iii)(C) of this section, shall be supplemented by at least one additional safety measure that provides a level of safety equivalent to that obtained by use of a lock. Examples of additional safety measures include the removal of an isolating circuit element, blocking of a controlling switch, or opening of an extra disconnecting device.

1910.333(b)(2)(iii)(E) [120.4(B)(11)(4)]
A lock may be placed without a tag only under the following conditions:

1910.333(b)(2)(iii)(E)(1)
Only one circuit or piece of equipment is deenergized, and

1910.333(b)(2)(iii)(E)(2)
The lockout period does not extend beyond the work shift, and

1910.333(b)(2)(iii)(E)(3) [110.5(B)(10)&(13)]
Employees exposed to the hazards associated with reenergizing the circuit or equipment are familiar with this procedure.

1910.333(b)(2)(iv) [120.5(B)(5) & (14)]
Verification of deenergized condition. The requirements of this paragraph shall be met before any circuits or equipment can be considered and worked as deenergized.

1910.333(b)(2)(iv)(A) [120.5(B), (120.6(7))]
A qualified person shall operate the equipment operating controls or otherwise verify that the equipment cannot be restarted.

1910.333(b)(2)(iv)(B) [120.6(7),(8)]
A qualified person shall use test equipment to test the circuit elements and electrical parts of equipment to which employees will be exposed and shall verify that the circuit elements and equipment parts are deenergized. The test shall also determine if any energized condition exists as a result of inadvertently induced voltage or unrelated voltage backfeed even though specific parts of the circuit have been deenergized and presumed to be safe. If the circuit to be tested is over 600 volts, nominal, the test equipment shall be checked for proper operation immediately after this test.

1910.333(b)(2)(v) [120.5(B)(12), (13), &(14)]
Reenergizing equipment. These requirements shall be met, in the order given, before circuits or equipment are reenergized, even temporarily.

1910.333(b)(2)(v)(A) [120.5(B)(13)]
A qualified person shall conduct tests and visual inspections, as necessary, to verify that all tools, electrical jumpers, shorts, grounds, and other such devices have been removed, so that the circuits and equipment can be safely energized.

1910.333(b)(2)(v)(B) [120.5(B)(13)]
Employees exposed to the hazards associated with reenergizing the circuit or equipment shall be warned to stay clear of circuits and equipment.

1910.333(b)(2)(v)(C) [120.5(12)]
Each lock and tag shall be removed by the employee who applied it or under his or her direct supervision. However, if this employee is absent from the workplace, then the lock or tag may be removed by a qualified person designated to perform this task provided that:

1910.333(b)(2)(v)(C)(1) [120.5(B)(12)]
The employer ensures that the employee who applied the lock or tag is not available at the workplace, and

1910.333(b)(2)(v)(C)(2) [120.5(B)(12)]
The employer ensures that the employee is aware that the lock or tag has been removed before he or she resumes work at that workplace.

1910.333(b)(2)(v)(D) [120.5(B)(13)]
There shall be a visual determination that all employees are clear of the circuits and equipment.

1910.333(c) [110] **Working on or near exposed energized parts.**

1910.333(c)(1) [130]
Application. This paragraph applies to work performed on exposed live parts (involving either direct contact or by means of tools or materials) or near enough to them for employees to be exposed to any hazard they present.

1910.333(c)(2) [130.1(1)]
Work on energized equipment. Only qualified persons may work on electric circuit parts or equipment that have not been deenergized under the procedures of paragraph (b) of this section. Such persons shall be capable of working safely on energized circuits and shall be familiar with the proper use of special precautionary techniques, personal protective equipment, insulating and shielding materials, and insulated tools.

1910.333(c)(3) [130.9 see table 130.4(E)(a)]
Overhead lines. if work is to be performed near overhead lines, the lines shall be deenergized and grounded, or other protective measures shall be provided before work is started. If the lines are to be deenergized, arrangements shall be made with the person or organization that operates or controls the electric circuits involved to deenergize and ground them. If protective measures, such as guarding, isolating, or insulating, are provided, these precautions shall prevent employees from contacting such lines directly with any part of their body or indirectly through conductive materials, tools, or equipment.
Note: The work practices used by qualified persons installing insulating devices on overhead power transmission or distribution lines are covered by 1910.269 of this Part, not by 1910.332 through 1910.335 of this Part. Under paragraph (c)(2) of this section, unqualified persons are prohibited from performing this type of work.

1910.333(c)(3)(i) [130] **Unqualified persons.**

1910.333(c)(3)(i)(A) [130.9(E)&(F), 130.4(F), 130.4(E)(a),(b) column 2]
When an unqualified person is working in an elevated position near overhead lines, the location shall be such that the person and the longest conductive object he or she may contact cannot come closer to any unguarded, energized overhead line than the following distances:

1910.333(c)(3)(i)(A)(1) [130.4(E)(a),(b) column 2]
For voltages to ground 50kV or below - 10 feet (305 cm);

1910.333(c)(3)(i)(A)(2) [130.4(E)(a),(b) column 2]
For voltages to ground over 50kV - 10 feet (305 cm) plus 4 inches (10 cm) for every 10kV over 50kV.

1910.333(c)(3)(i)(B) [130.4(E)(a),(b) column 2]
When an unqualified person is working on the ground in the vicinity of overhead lines, the person may not bring any conductive object closer to unguarded, energized overhead lines than the distances given in paragraph (c)(3)(i)(A) of this section.
Note: For voltages normally encountered with overhead power line, objects which do not have an insulating rating for the voltage involved are considered to be conductive.

1910.333(c)(3)(ii) [130.4(G), 130.9] See also 1910.269 Power Generation Transmission & Distribution
Qualified persons. When a qualified person is working in the vicinity of overhead lines, whether in an elevated position or on the ground, the person may not approach or take any conductive object without an approved insulating handle closer to exposed energized parts than shown in Table S-5 unless:

1910.333(c)(3)(ii)(A) [130.4(G)] See also 1910.269
The person is insulated from the energized part (gloves, with sleeves if necessary, rated for the voltage involved are considered to be insulation of the person from the energized part on which work is performed), or

1910.333(c)(3)(ii)(B) [130.4(G)] See also 1910.269
The energized part is insulated both from all other conductive objects at a different potential and from the person, or

1910.333(c)(3)(ii)(C) [Live Line Bare Hand work removed from the 2018 edition 70E]
The person is insulated from all conductive objects at a potential different from that of the energized part.
TABLE S-5 - APPROACH DISTANCES FOR QUALIFIED EMPLOYEES - ALTERNATING CURRENT
[Table 130.4(G)]

Voltage range (phase to phase)	Minimum approach distance
300V and less	Avoid Contact
Over 300V, not over 750V	1 ft. 0 in. (30.5 cm).
Over 750V, not over 2kV	1 ft. 6 in. (46 cm).
Over 2kV, not over 15kV	2 ft. 0 in. (61 cm).
Over 15kV, not over 37kV	3 ft. 0 in. (91 cm).
Over 37kV, not over 87.5kV	3 ft. 6 in. (107 cm).
Over 87.5kV, not over 121kV	4 ft. 0 in. (122 cm).
Over 121kV, not over 140kV	4 ft. 6 in. (137 cm).

1910.333(c)(3)(iii) [130.9(F)] **Vehicular and mechanical equipment.**

1910.333(c)(3)(iii)(A) [130.9(F)]
Any vehicle or mechanical equipment capable of having parts of its structure elevated near energized overhead lines shall be operated so that a clearance of 10 ft. (305 cm) is maintained. If the voltage is higher than 50kV, the clearance shall be increased 4 in. (10 cm) for every 10kV over that voltage. However, under any of the following conditions, the clearance may be reduced:

1910.333(c)(3)(iii)(A)(1) [130.9(F)(1)&(2)]
If the vehicle is in transit with its structure lowered, the clearance may be reduced to 4 ft. (122 cm). If the voltage is higher than 50kV, the clearance shall be increased 4 in. (10 cm) for every 10 kV over that voltage.

1910.333(c)(3)(iii)(A)(2) [130.9(F)(2)] see also 1910.269
If insulating barriers are installed to prevent contact with the lines, and if the barriers are rated for the voltage of the line being guarded and are not a part of or an attachment to the vehicle or its raised structure, the clearance may be reduced to a distance within the designed working dimensions of the insulating barrier.
1910.333(c)(3)(iii)(A)(3) [130.9(F)(1)] see also 1910.269

If the equipment is an aerial lift insulated for the voltage involved, and if the work is performed by a qualified person, the clearance (between the uninsulated portion of the aerial lift and the power line) may be reduced to the distance given in Table S-5.

1910.333(c)(3)(iii)(B) [130.9(F)(2)]
Employees standing on the ground may not contact the vehicle or mechanical equipment or any of its attachments, unless:

1910.333(c)(3)(iii)(B)(1) [130.9(F)(2)(1)]
The employee is using protective equipment rated for the voltage; or

1910.333(c)(3)(iii)(B)(2) [130.9(F)(2)(2)]
The equipment is located so that no uninsulated part of its structure (that portion of the structure that provides a conductive path to employees on the ground) can come closer to the line than permitted in paragraph (c)(3)(iii) of this section.

1910.333(c)(3)(iii)(C) [130.9(F)(3)]
If any vehicle or mechanical equipment capable of having parts of its structure elevated near energized overhead lines is intentionally grounded, employees working on the ground near the point of grounding may not stand at the grounding location whenever there is a possibility of overhead line contact. Additional precautions, such as the use of barricades or insulation, shall be taken to protect employees from hazardous ground potentials, depending on earth resistivity and fault currents, which can develop within the first few feet or more outward from the grounding point.

1910.333(c)(4) [130.8(C)] **Illumination.**

1910.333(c)(4)(i) [130.8(C)(1)]
Employees may not enter spaces containing exposed energized parts, unless illumination is provided that enables the employees to perform the work safely.

1910.333(c)(4)(ii) [130.8(C)(2)]
Where lack of illumination or an obstruction precludes observation of the work to be performed, employees may not perform tasks near exposed energized parts. Employees may not reach blindly into areas which may contain energized parts.

1910.333(c)(5) [130.8(F)]
Confined or enclosed work spaces. When an employee works in a confined or enclosed space (such as a manhole or vault) that contains exposed energized parts, the employer shall provide, and the employee shall use, protective shields, protective barriers, or insulating materials as necessary to avoid inadvertent contact with these parts. Doors, hinged panels, and the like shall be secured to prevent their swinging into an employee and causing the employee to contact exposed energized parts.

1910.333(c)(6) [130.8(E)]
Conductive materials and equipment. Conductive materials and equipment that are in contact with any part of an employee's body shall be handled in a manner that will prevent them from contacting exposed energized conductors or circuit parts. If an employee must handle long dimensional conductive objects (such as ducts and pipes) in areas with exposed live parts, the employer shall institute work practices (such as the use of insulation, guarding, and material handling techniques) which will minimize the hazard.

1910.333(c)(7) [130.7(D)(1)(e)]
Portable ladders. Portable ladders shall have nonconductive side rails if they are used where the employee or the ladder could contact exposed energized parts.

1910.333(c)(8) [130.8(D)]
Conductive apparel. Conductive articles of jewelry and clothing (such a watch bands, bracelets, rings, key chains, necklaces, metalized aprons, cloth with conductive thread, or metal headgear) may not be worn if they might contact exposed energized parts. However, such articles may be worn if they are rendered nonconductive by covering, wrapping, or other insulating means.

1910.333(c)(9) [130.8(I)]
Housekeeping duties. Where live parts present an electrical contact hazard, employees may not perform housekeeping duties at such close distances to the parts that there is a possibility of contact, unless adequate safeguards (such as insulating equipment or barriers) are provided. Electrically conductive cleaning materials (including conductive solids such as steel wool, metalized cloth, and silicon carbide, as well as conductive liquid solutions) may not be used in proximity to energized parts unless procedures are followed which will prevent electrical contact.

1910.333(c)(10) [130.8(N)]
Interlocks. Only a qualified person following the requirements of paragraph (c) of this section may defeat an electrical safety interlock, and then only temporarily while he or she is working on the equipment. The interlock system shall be returned to its operable condition when this work is completed.

1910.334(a) [110.7] **Portable electric equipment.**
This paragraph applies to the use of cord and plug connected equipment, including flexible cord sets (extension cords).

1910.334(a)(1) [110.7(A)]
Handling. Portable equipment shall be handled in a manner which will not cause damage. Flexible electric cords connected to equipment may not be used for raising or lowering the equipment. Flexible cords may not be fastened with staples or otherwise hung in such a fashion as could damage the outer jacket or insulation.

1910.334(a)(2) [110.7(C)] **Visual inspection.**

1910.334(a)(2)(i) [110.7(C)(a)]
Portable cord and plug connected equipment and flexible cord sets (extension cords) shall be visually inspected before use on any shift for external defects (such as loose parts, deformed and missing pins, or damage to outer jacket or insulation) and for evidence of possible internal damage (such as pinched or crushed outer jacket). Cord and plug connected equipment and flexible cord sets (extension cords) which remain connected once they are put in place and are not exposed to damage need not be visually inspected until they are relocated.

1910.334(a)(2)(ii) [110.7(C)(b)]
If there is a defect or evidence of damage that might expose an employee to injury, the defective or damaged item shall be removed from service, and no employee may use it until repairs and tests necessary to render the equipment safe have been made.

1910.334(a)(2)(iii) [110.7(C)(c)]
When an attachment plug is to be connected to a receptacle (including an on a cord set), the relationship of the plug and receptacle contacts shall first be checked to ensure that they are of proper mating configurations.

1910.334(a)(3) [110.7(B)] **Grounding type equipment.**

1910.334(a)(3)(i) [110.7(B)(a)]
A flexible cord used with grounding type equipment shall contain an equipment grounding conductor.

1910.334(a)(3)(ii) [110.7(B)(b)]
Attachment plugs and receptacles may not be connected or altered in a manner which would prevent proper continuity of the equipment grounding conductor at the point where plugs are attached to receptacles. Additionally, these devices may not be altered to allow the grounding pole of a plug to be inserted into slots intended for connection to the current-carrying conductors.

1910.334(a)(3)(iii) [110.7(B)(c)]
Adapters which interrupt the continuity of the equipment grounding connection may not be used.

1910.334(a)(4) [110.7(D)]
Conductive work locations. Portable electric equipment and flexible cords used in highly conductive work locations (such a those inundated with water or other conductive liquids), or in job locations where employees are likely to contact water or conductive liquids, shall be approved for those locations.

1910.334(a)(5) [110.7(E)] **Connecting attachment plugs.**

1910.334(a)(5)(i) [110.7(E)(a)]
Employees' hands may not be wet when plugging and unplugging flexible cords and cord and plug connected equipment, if energized equipment is involved.

1910.334(a)(5)(ii) [110.7(E)(b)]
Energized plug and receptacle connections may be handled only with insulating protective equipment if the condition of the connection could provide a conducting path to the employee's hand (if, for example, a cord connector is wet from being immersed in water).

1910.334(a)(5)(iii) [110.7(E)(c)]
Locking type connectors shall be properly secured after connection.

1910.334(b) **Electric power and lighting circuits.**

1910.334(b)(1) [130.8(L)]
Routine opening and closing of circuits. Load rated switches, circuit breakers, or other devices specifically designed as disconnecting means shall be used for the opening, reversing, or closing of circuits under load conditions. Cable connectors not of the load break type, fuses, terminal lugs, and cable splice connections may not be used for such purposes, except in an emergency.

1910.334(b)(2) [130.8(M)]
Reclosing circuits after protective device operation. After a circuit is deenergized by a circuit protective device, the circuit protective device, the circuit may not be manually reenergized until it has been determined that the equipment and circuit can be safely energized. The repetitive manual reclosing of circuit breakers or reenergizing circuits through replaced fuses is prohibited.
Note: When it can be determined from the design of the circuit and the overcurrent devices involved that the automatic operation of a device was caused by an overload rather than a fault condition, no examination of the circuit or connected equipment is needed before the circuit is reenergized.

1910.334(b)(3) [110.9]
Overcurrent protection modification. Overcurrent protection of circuits and conductors may not be modified, even on a temporary basis, beyond that allowed by 1910.304(e), the installation safety requirements for overcurrent protection.

1910.334(c) [110.6] **Test instruments and equipment.**

1910.334(c)(1) [110.6(A)]
Use. Only qualified persons may perform testing work on electric circuits or equipment.

1910.334(c)(2) [110.6(D)]
Visual inspection. Test instruments and equipment and all associated test leads, cables, power cords, probes, and connectors shall be visually inspected for external defects and damage before the equipment is used. If there is a defect or evidence of damage that might expose an employee to injury, the defective or damaged item shall be removed from service, and no employee may use it until repairs and tests necessary to render the equipment safe have been made.

1910.334(c)(3) [110.6(B)]
Rating of equipment. Test instruments and equipment and their accessories shall be rated for the circuits and equipment to which they will be connected and shall be designed for the environment in which they will be used.

1910.334(d) [130.8(J)]
Occasional use of flammable or ignitable materials. Where flammable materials are present only occasionally, electric equipment capable of igniting them shall not be used, unless measures are taken to prevent hazardous conditions from developing. Such materials include, but are not limited to: flammable gases, vapors, or liquids; combustible dust; and ignitable fibers or flyings.
Note: Electrical installation requirements for locations where flammable materials are present on a regular basis are contained in 1910.307.

1910.335(a)(1) [130.7] **Personal protective equipment.**

1910.335(a)(1)(i) [130.7(A)]
Employees working in areas where there are potential electrical hazards shall be provided with, and shall use, electrical protective equipment that is appropriate for the specific parts of the body to be protected and for the work to be performed.

Note: Personal protective equipment requirements are contained in subpart I of this part.

1910.335(a)(1)(ii) [130.7(B), (C)] Table 130.7(C)(14) ASTM standards changed to non-mandatory information note See OSHA 1910.137

Protective equipment shall be maintained in a safe, reliable condition and shall be periodically inspected or tested, as required by 1910.137.

1910.335(a)(1)(iii) [130.7(G), 130.7(C)(7) see 1910.137, ASTM F-496 & F696
If the insulating capability of protective equipment may be subject to damage during use, the insulating material shall be protected. (For example, an outer covering of leather is sometimes used for the protection of rubber insulating material.)

1910.335(a)(1)(iv) [130.7(C)(3)]
Employees shall wear nonconductive head protection wherever there is a danger of head injury from electric shock or burns due to contact with exposed energized parts.

1910.335(a)(1)(v) [130.7(C)(3)&(4)]
Employees shall wear protective equipment for the eyes or face wherever there is danger of injury to the eyes or face from electric arcs or flashes or from flying objects resulting from electrical explosion.

1910.335(a)(2) [130.7(D)] **General protective equipment and tools.**

1910.335(a)(2)(i) [130.7(D)(1)]
When working near exposed energized conductors or circuit parts, each employee shall use insulated tools or handling equipment if the tools or handling equipment might make contact with such conductors or parts. If the insulating capability of insulated tools or handling equipment is subject to damage, the insulating material shall be protected.

1910.335(a)(2)(i)(A) [130.7(D)(1)(b)]
Fuse handling equipment, insulated for the circuit voltage, shall be used to remove or install fuses when the fuse terminals are energized.

1910.335(a)(2)(i)(B) [130.7(D)(1)(c)]
Ropes and handlines used near exposed energized parts shall be nonconductive.

1910.335(a)(2)(ii) [130.7(D)(2)(a,b,c), 130.10]
Protective shields, protective barriers, or insulating materials shall be used to protect each employee from shock, burns, or other electrically related injuries while that employee is working near exposed energized parts which might be accidentally contacted or where dangerous electric heating or arcing might occur. When normally enclosed live parts are exposed for maintenance or repair, they shall be guarded to protect unqualified persons from contact with the live parts.

1910.335(b) [130.8(O)]
Alerting techniques. The following alerting techniques. The following alerting techniques shall be used to warn and protect employees from hazards which could cause injury due to electric shock, burns, or failure of electric equipment parts:

1910.335(b)(1) [130.8(O)(1)]
Safety signs and tags. Safety signs, safety symbols, or accident prevention tags shall be used where necessary to warn employees about electrical hazards which may endanger them, as required by 1910.145.

(O)(2)]

Barricades shall be used conjunction with safety signs where it is necessary to prevent or limit ccess to work areas expos employees to uninsulated energized conductors or circuit parts. barricades may not be use where they might cause an electrical contact hazard.

3) [130.8(O)(3)]

If signs and barricades do not provide sufficient warning and protection from electrical hazards, an ll be stationed to warn and protect employees.